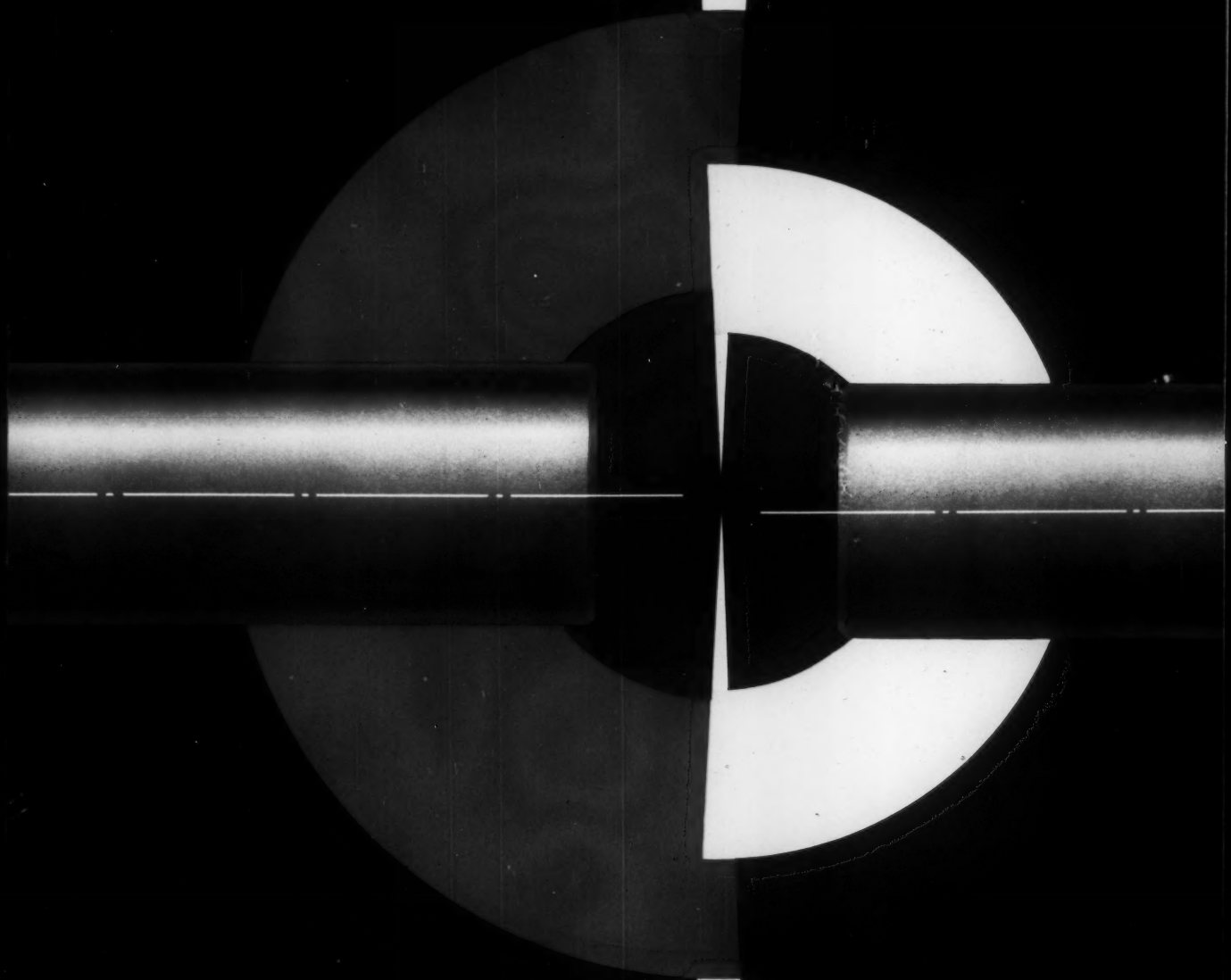
OCTOBER 30, 1958

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Flexible Couplings

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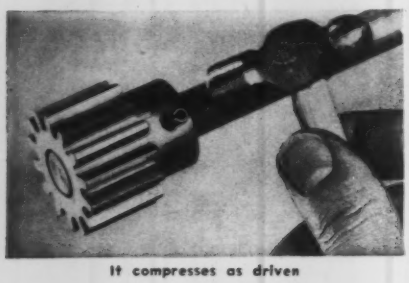
FARNSWORTH

Where can you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven

Rollpin fits flush . . . is vibration-proof

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.

Elastic Stop Nut Corporation of America
Dept. R16-104, 2330 Vauxhall Road, Union, N. J.
Please send me the following free fastening information:

☐ Rollpin bulletin
☐ Elastic Stop Nut bulletin
☐ Here is a drawing of our product. What fastener would you suggest?

Name _____ *Title* _____
Firm _____
Street _____
City _____ *Zone* _____ *State* _____

Circle 401 on Page 19

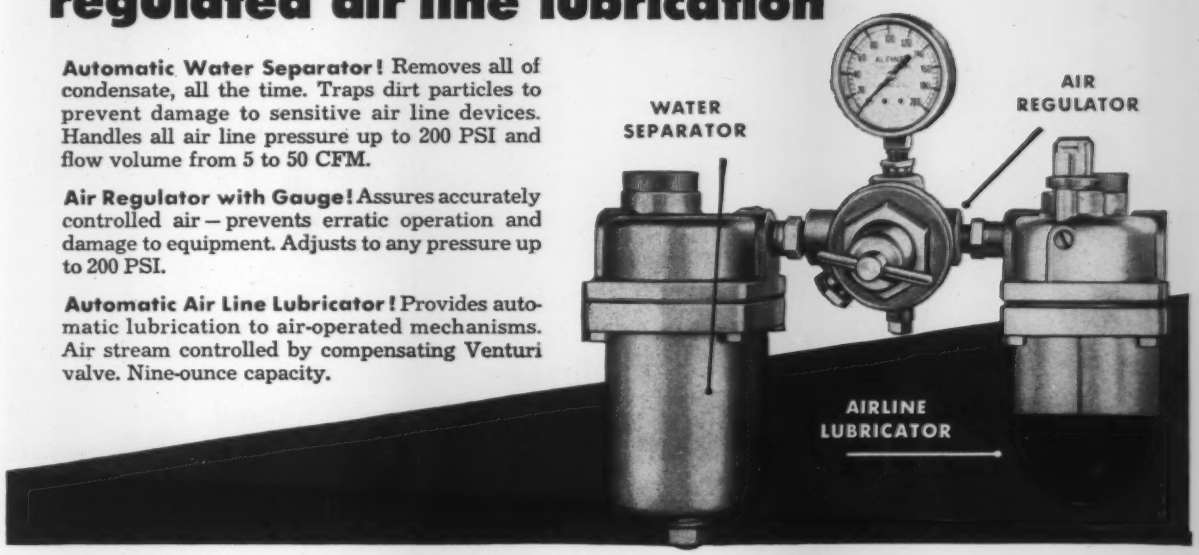
Alemite "Tri-Duty" air line controls!

All-New...for the cleanest, driest, best-regulated air line lubrication

Automatic Water Separator! Removes all of condensate, all the time. Traps dirt particles to prevent damage to sensitive air line devices. Handles all air line pressure up to 200 PSI and flow volume from 5 to 50 CFM.

Air Regulator with Gauge! Assures accurately controlled air — prevents erratic operation and damage to equipment. Adjusts to any pressure up to 200 PSI.

Automatic Air Line Lubricator! Provides automatic lubrication to air-operated mechanisms. Air stream controlled by compensating Venturi valve. Nine-ounce capacity.



All-New features offer outstanding advantages:

1. Single Unit Control Lubricator. Regulates the exact oil output required.

2. Visual Oil Counter. Oil sight dome in lubricator permits visual observation and count "per-drop" of lubrication.

3. Uniform Oil Mixture. Regardless of air pressure and volume!

4. Consistent Output. Oil and air mixture proportionately constant.

5. Easily Installed. Straight "inline" pipe connections . . . ½" p.t. inlet and outlet ports.

6. Wide Oil Range. Handles all viscosities of oil up to 500 SSU at 100° F.

7. Continuous Operation. Oil reservoir is refillable while unit is in operation.

8. Instant Oil Feed. For intermittent or continuous tool operation—no lag!

9. Filter Oil Tube. Removes all contamination from oil passing into air line.

10. Concentric Venturi Design. Assures constant, uniform mixture of air and oil.

11. Contamination-Free Air. Removable strainer in Air Regulator traps minute dirt particles.

12. Effective Control of Air Flow. Air Regulator eliminates excessive pressures and sudden surges.

13. 100% Condensate Removal. Water Separator removes and automatically dumps 100% of the condensate present in air lines.

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STEWART-WARNER CORPORATION
1850 Diversey Parkway, Chicago 14, Illinois

ALEMITE, Dept. BB-108
1850 Diversey Parkway, Chicago 14, Illinois
Please send me all the facts about Alemite's new "Tri-Duty" Air Line Controls.

Name.....
Company.....
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City.....Zone.....State.....

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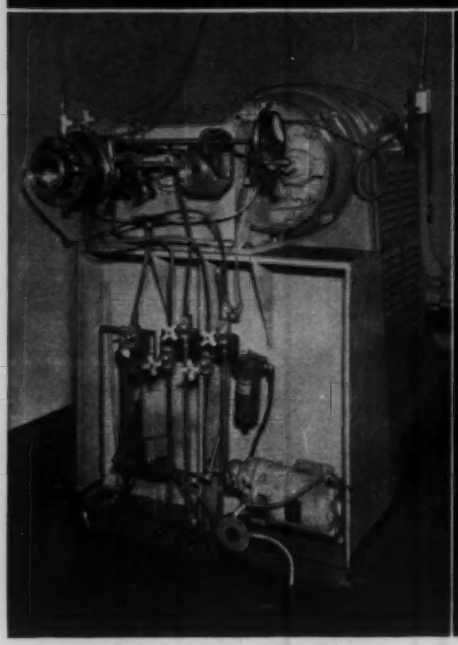
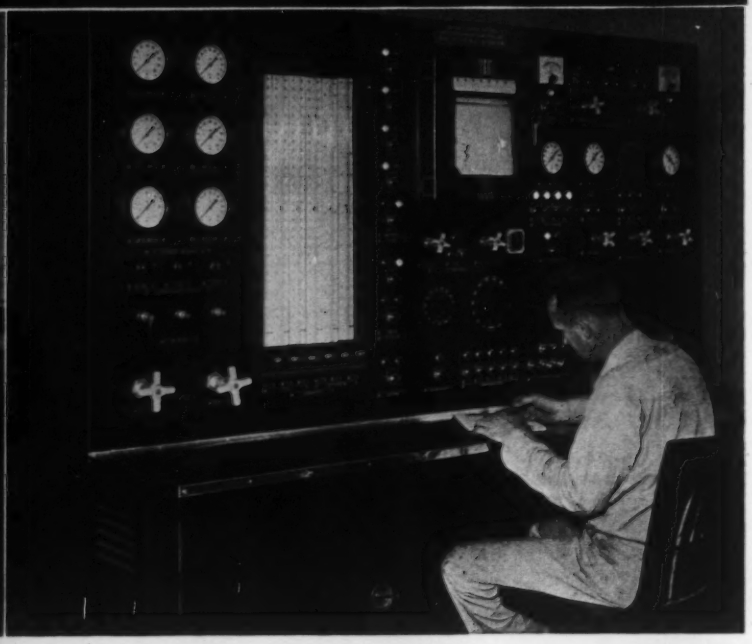
Breakthrough





New C/R high-speed laboratories ...testing seals at tomorrow's speeds!

Pushing a design program through on schedule means that there can be no slow-down in any phase. If you know there's a high-speed sealing problem ahead — an accessory drive for a new jet, a hot, fast-rotating shaft in a guided missile, or a bearing in tomorrow's turbine car — plan for it now. Here in Chicago Rawhide's new High-Speed Seal Test Laboratory, C/R engineers now are breaking through present limits, evaluating the design and performance of advanced seal types such as end face, controlled gap, bellows, segmental and bore type seals under such punishing conditions as 80,000 R.P.M., –300° to +1000°F. and 500 psi. C/R is at your service *now* with the most advanced technology and facilities in the country for cooperative research on high-speed sealing problems.

Chicago Rawhide consistently gears itself to the future, ready to meet industry's new problems as they develop today. May we help you?

More automobiles, farm and industrial machines rely on C/R Oil Seals than on any similar sealing device.

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C/R PRODUCTS: C/R Shaft and End Face Seals • Sirvene (synthetic rubber) molded pliable parts • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears

C/R OIL SEAL DIVISION
CHICAGO RAWHIDE

Front Cover: Flexible couplings—designed to prevent headaches where shafts are misaligned—are epitomized by artist George Farnsworth. A complete guide to available types, prepared by associate editor Leo Spector, appears on Page 101.

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Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, $10. Single copies $1.00. Other countries: One year, $25. When requesting changes of address, etc., please allow four to six weeks for processing.

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NEW MANUAL STARTER

that challenges comparison!

CLARK BULLETIN 6002
Type "CM" MANUAL STARTER
Sizes 0 and 1

• Here is a new manual started designed to provide standards of protection and performance normally associated with magnetic starters. It can be used wherever relatively small motors (up to 7½ HP) are started across-the-line, and remote control is not required.

Compared feature by feature with other manual starters, the new Clark Type "CM" is readily recognized as the outstanding leader in its field. Some of these features are listed at the right. It is available in sizes 0 and 1, non-reversing, reversing and two-speed types, open and enclosed models.

Write for descriptive Bulletin 6002 CM.

Compare these features

- **SMOOTH, POSITIVE OPERATION**—Unique design of over-center, toggle type operating mechanism gives exceptionally smooth, positive snap-action opening and closing, and virtually eliminates danger of accidental operation by shock or vibration.
- **RUGGED CONSTRUCTION**—One piece housing molded of strong non-carbonizing material completely shrouds operating mechanism to protect from dust and dirt. Built-in arc barriers prevent flash-overs even under heavy overloads.
- **STRAIGHT-THRU WIRING**—Line terminals at top and load terminals at bottom simplify installation.
- **RECESSED OPERATING HANDLE**—No danger of accidental operation when in "OFF" position, yet easy to operate, even with gloves on. "OFF", "RESET" and "TRIPPED" conditions clearly indicated.
- **TRIP-FREE OPERATION**—When melting-alloy overload relay trips and opens starter, contacts cannot be reclosed until overload relay and motor cool to safe operating temperature. Contacts cannot be held closed against an overload.
- **TEASE-FREE MECHANISM**—Snap-action contacts cannot be opened or closed slowly.
- **LARGE, DOUBLE-BREAK, NON-WELDING CONTACTS**—Long wearing silver-alloy contacts give extra long life and high current carrying capacity.
- **SIMPLIFIED MAINTENANCE**—Contacts easily inspected and replaced *from the front* without removing starter from cabinet.
- **MORE FAIL-SAFE**—Positive-acting mechanism has dual operating springs, either one capable of operating starter.
- **OPTIONAL THIRD-LINE OVERLOAD**—For three-phase applications requiring overload protection in each line, a third built-in overload is available, or may be added in the field.
- **THREE SAFE-LOCKING FEATURES**—Standard locking devices include: interlock to prevent removal of cover when starter is "ON"; safety latch on the operating lever which can be set to lock starter in "OFF" position, and cannot be released with the cover padlocked. Optional device also available permits padlocking starter in either "ON" or "OFF" position.

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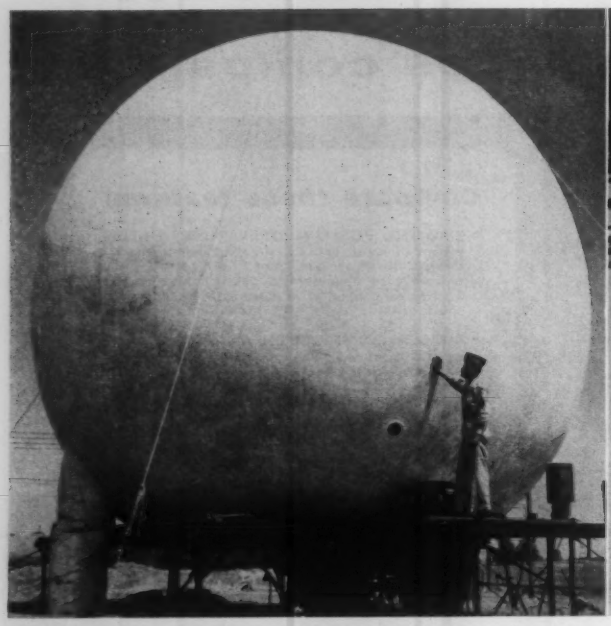
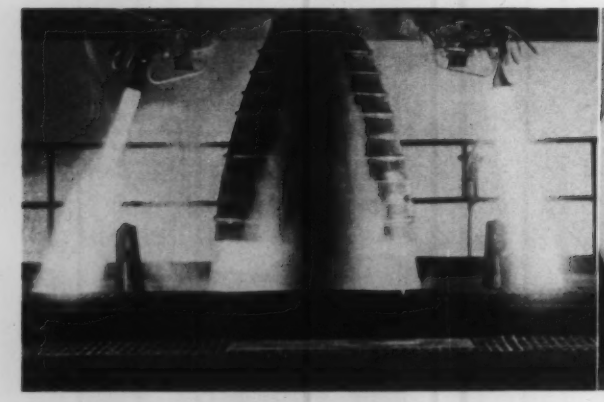
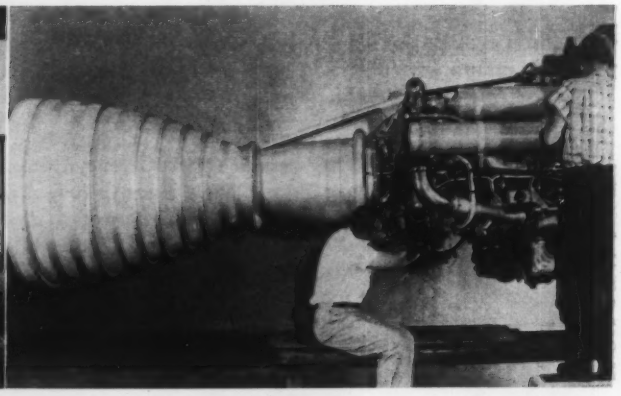
ENGINEERING NEWS



Motionless Scanner

A new search radar that detects airborne targets at extreme range and computes distance, bearing, and altitude, uses a single motionless antenna. The radar incorporates frequency scanning—angle of radiation from the antenna depends upon signal frequency. Advantages of the system are numerous: Motors, gears, and other antenna-drive units are eliminated, and since the system works electronically, it will scan the hemisphere at electronic speeds. As a further refinement, digital programming is used to assure maximum accuracy and coverage during the scanning procedure. Developed by Hughes Aircraft Co., the new mobile system will be used by Army air defense as a guided-missile fire-distribution center. Inflatable radome encloses the antenna in the field, and consoles are trailer mounted.

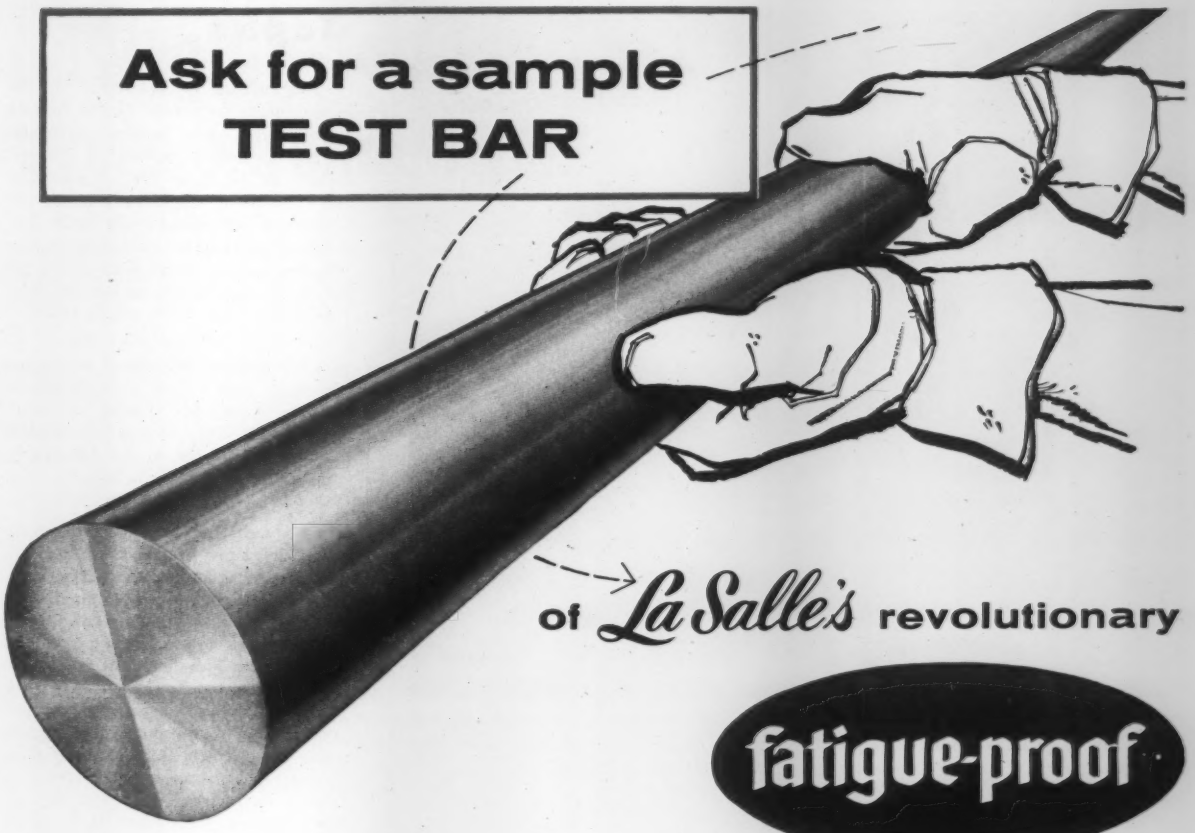




First Stage to the Moon

Nearly ¾ of the power needed to orbit an Air Force moon probe is supplied in 2½ min by the 150,000-lb thrust Thor engine. The powerful liquid propulsion system—a main booster flanked by two small verniers—drives the moon-bound package to a speed of 10,000 mph and an altitude of 90 mi. It also defines directional attitude of the vehicle in its critical base trajectory. The inertial guidance system controls gimbaling of all three engines. North American Aviation's Rocketdyne Div. began Thor engine development late in 1955. First IRBM launching followed in two years.

Ask for a sample TEST BAR



of La Salle's revolutionary

fatigue-proof steel

The steel bar that has high strength WITHOUT HEAT TREATING

Yes, La Salle invites you to test a sample bar of the remarkable new FATIGUE-PROOF. This amazing new material is its own best recommendation . . . as proven by the many original equipment manufacturers who have already tested (and are using) FATIGUE-PROOF.

If you are making parts requiring strengths in the tensile range of 140,000 to 150,000 psi, and want to eliminate the expense or problems of heat treating . . . if you want to save production costs with a bar that machines faster (25% faster than annealed alloys—50% to 100% faster than heat treated alloys) and gives you a beautiful finish, too . . . if you want to improve the quality of your product while saving money, send us a blueprint, drop us a note giving application details, or better yet . . . pick up your telephone and call a La Salle sales engineer (REgent 4-7800, Chicago, Illinois).

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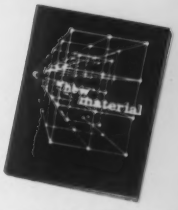
Get your copy of "a new material," a 24-page booklet which gives detailed information on La Salle "FATIGUE-PROOF"® steel bars.



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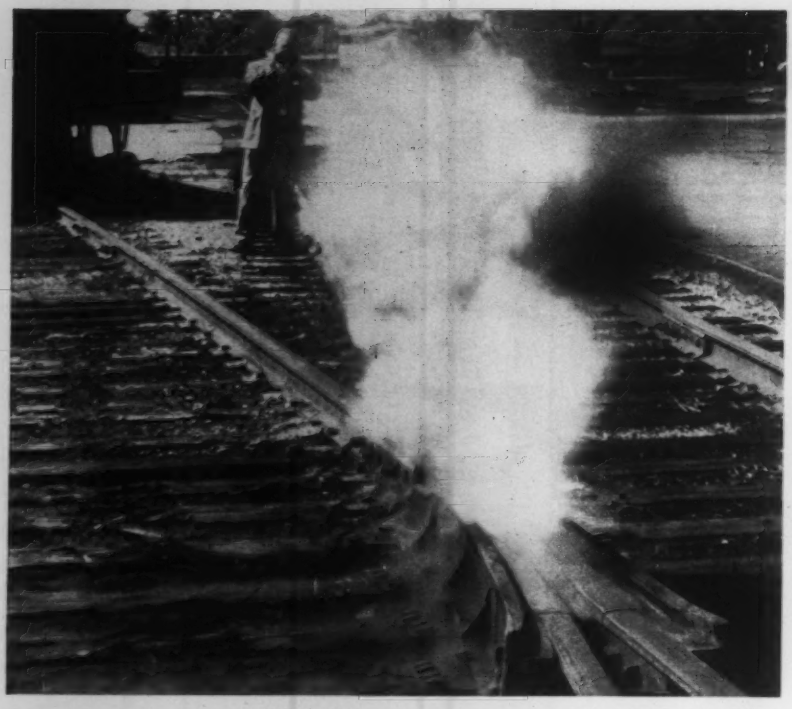


Five times its former useful life (20 vs. 4 years) is expected for this railroad frog being treated with the new shock-hardening process developed by New York Central Railroads. An explosive plastic strip supplies the shock.

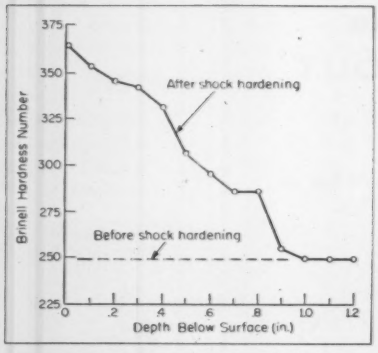
Shock-Hardening Process Boosts Steel Tensile Strength

Frog Life Up 500 Per Cent After Explosive Treatment

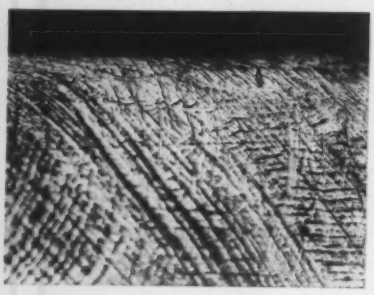
CLEVELAND — An explosive shock-hardening process which significantly increases the life expectancy of hard-working steel parts, like railroad-switch frogs, has been announced by New York Central Railroads. Energy for the process is provided by a new plastic explosive which handles like a strip of rubber. Applicable to components already in place, the strip is taped to the area to be hardened and detonated with a common blasting cap.

Results superior to work-hardening by conventional methods are reported by NYC research engineer, Donald Mallock. In a typical application of the explosive process, the blast increased the tensile strength of a frog from 120,000 to 176,000 psi. Mr. Mallock believes that with heavier charges the tensile strength can be increased to as high as 250,000 psi.

In contrast to conventional quench-hardening processes—where



Shock-wave penetration to a depth of 1 in. is shown by graph of Brinell hardness vs. penetration depth. Photomicrograph shows compression of crystal structure due to shock.



Topics

The earbone is "connected" to the sound plate in a new Zenith hearing aid that uses bone conduction instead of an in-the-ear button to transmit sound to the inner ear. A four-transistor receiver, amplifier, volume control, and microphone are built into one temple bar of an eyeglasses-type hearing aid. A sound plate at the top of the temple bar fits against the mastoid bone behind the wearer's ear.

• • •

Do-it-yourself filter-tip cigarettes can be made with a little machine offered in the Christmas catalog of Sears, Roebuck & Co. A pack of cigarettes can be turned out in ten minutes by the modern smoker who rolls his own.

• • •

A squeeze from the cook will be common procedure in preparing meals in the future, according to the Collapsible Tube Manufacturers Council. The Council predicts wide use of "toothpaste" tubes in packaging meat and cheese spreads, butter, sour cream, etc. It also foresees merchandising possibilities in vending-machine sale of such packages and—optimistically—suggests that tubed goodies are just the thing for a picnic because the children can "do it themselves." For a more practical purpose, space-travel planners are interested in collapsible tubes as a means of getting food into people in gravityless atmospheres.

• • •

Inside-out world will be built by Battelle Memorial Institute for top Air Force strategists. A detailed map of the northern hemisphere will be placed on the inside of a 20-ft diam bowl for optimum viewing by 20 USAF global operations planners sitting at desks in terraced rows facing it.

• • •

Fewer wheels mean faster travel, according to results of a "race" among a variety of vehicles held recently in Germany. On an 8½-mile course through rush-hour traffic in Stuttgart, a motor bike finished first in 24 minutes. It was closely followed by a motorcycle, then a motor scooter. A small European car took 38 minutes. Two minutes later came the also-ran contestant—a big American car.

• • •

A wetter mousetrap, with a capacity of 100 drowned mice, has been built by Self-Sett Mousetrap Co., Cleveland. The smell of food lures the victim through one of two entrances and up a ramp which tips like a seesaw. This action closes the door the mouse entered and resets the trap. The mouse's last few steps are up a ladder and a second ramp which tilts to deposit him in a water tank.

New high-torque low-current DC motor covers extended range of output speeds

The new Cramer Type 800 direct current motor offers an unusually wide range of output speeds, coupled with low current drain, high torque, high efficiency, and excellent speed stability. These features make it the ideal choice for timing devices, remote control equipment, recorders, signalling equipment, communications gear, displays, flashers, chart transports, and many other products.

Type 800 DC motor with standard gear train — shown 50% oversize

Wide Performance Range

Depending on requirements of speed, torque, and voltage, the rotor is wound to produce a basic motor speed of 960 to 3000 rpm. A gear train then reduces this to the speed required at the output shaft. Low rotor speeds result in lower current drain at all speed-torque combinations, but limit the torque available at the higher output speeds. Higher rotor speeds require a somewhat higher input current, but greatly increase the torque available at the higher output speeds.

The Table at lower right illustrates this flexibility of design, with a few examples from the virtually unlimited range of performance characteristics which it provides. Where very low input current is required, and the supply voltage does not exceed 12 volts, the use of the low-speed rotor will provide 30 oz. in. at speeds below 3 rpm and 0.5 oz. in. at 200 rpm. The higher speed rotors meet the requirements of higher input voltages, and provide greatly increased torque at the higher output speeds with only a moderate increase in current drain. The high-torque motor has the additional advantage of speed stability within 10% from no-load to full-load, at speeds below 5 rpm.

The examples given in the Table are for illustration only. By correct choice of rotor winding and gear ratio, an unlimited number of operating specifications can be established throughout the entire range shown. The motor is also available without gear train, for output torques of 0.1 to 0.6 oz. in. at speeds up to 3000 rpm.

OUTPUT SPEEDS WITH GEAR TRAINS	960 RPM ROTOR LOW INPUT CURRENT *(3 to 12 volts DC)*		3000 RPM ROTOR HIGH OUTPUT TORQUE *(3 to 30 volts DC)*	
	INPUT VOLT-AMPERES	OUTPUT TORQUE OZ. IN.	INPUT VOLT-AMPERES	OUTPUT TORQUE OZ. IN.
2 rpd	.16	30	.....	.....
1/6 rpm	.16	30	.56	30
3 rpm	.35	24	.64	30
10 rpm	.35	8.5	1.04	30
30 rpm	.35	3.0	1.72	21
60 rpm	.35	1.5	1.72	12
80 rpm	.35	1.1	1.72	8.5
200 rpm	.35	.5	1.72	3.5
900 rpm	.....	.....	1.90	.8

Typical Performance of Type 800 DC Motors for Minimum Input Current or Maximum Output Torque

Specifications

SPEEDS — 2 rpd to 900 rpm with gear train, 960 rpm to 3000 rpm without gear train.

TORQUE — 0.1 to 0.6 oz. in. without gear train, and to 30 oz. in. with gear train.

CURRENT DRAIN — as low as 30 milliamperes, depending on voltage, load and speed.

VOLTAGES — from 3 to 30 volts DC.

REVERSING OPERATION — with negligible speed difference, because of special motor design.

GEARS — precision-hobbed throughout, totally enclosed and with sealed-in lubricant.

For your free copy of informative Bulletin PB-800, write:

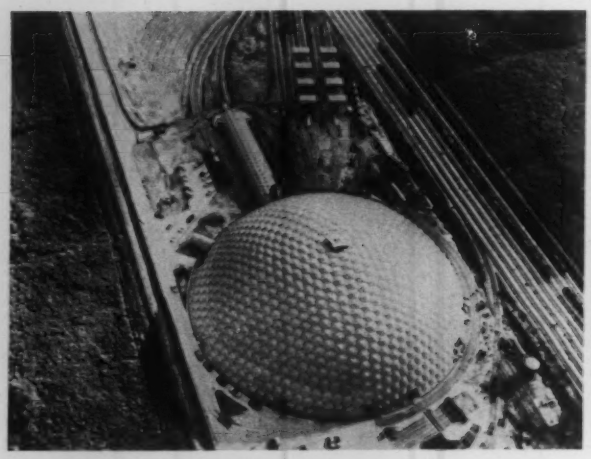
CRAMER CONTROLS CORPORATION

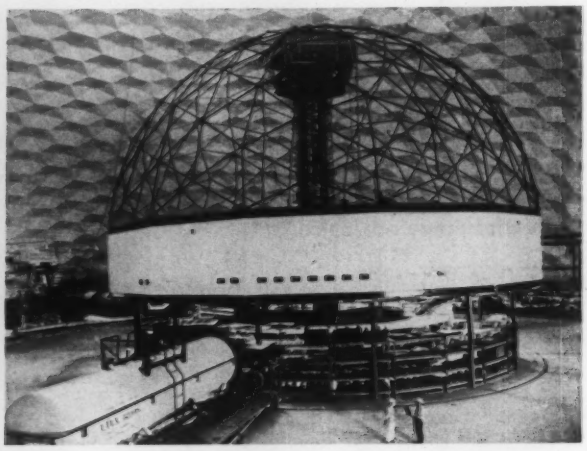
Box 6, Centerbrook, Connecticut

Circle 408 on Page 19

tough, comparatively soft Austenite structure is converted to hard-brittle Martensite — suddenness of the hardening shock does not allow shock energy to be changed to heat, thus conserving it for much deeper penetration and avoiding conversion of the Austenitic structure.

High magnesium steel was used in the test. NYC engineers point out that any steel alloy suitable for work-hardening can also be hardened by the new process. Possible applications include bulldozer blades, clamshell and bucket jaws, and car bumpers. NYC says little skill is demanded in the process.





First Real Roundhouse

The world's largest circular building without internal supports, a 384-ft diameter, ten-story-high geodesic dome, provides new efficiency for railroad-car repair operations. Fabricated entirely of steel, the structure epitomizes design simplicity—there were only seven different items on the bill of materials for the dome itself. Standard 11-gage (1/8-in.) sheet steel, cut into 321 hexagonal panels averaging 30 ft across, were welded together and strengthened on the outside by an interlocking system of 3/4-in rods and 4-in. pipes. Interior of the dome, right, contains a dome-shaped control tower seven stories high and 100 ft in diameter. All repairs are made as the car travels a circular route around the big-dome interior. George F. Hunt, New York, designed the structure for Union Tank Car Co.

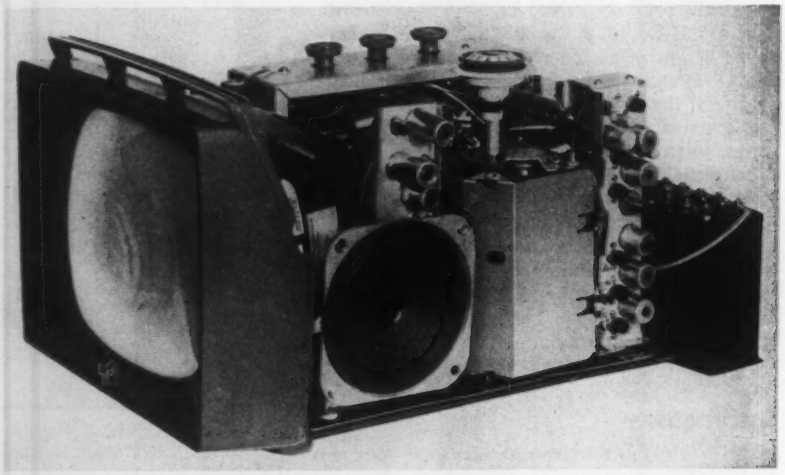
New Process Plates Chrome on Aluminum

UNION, N. J.—A dense coat of chromium is deposited directly on an aluminum base without an intermediate metal plate in a new process announced by Service Hard-Chromium Co., Union, N. J. While imparting chromium's typical longer-wearing qualities, the coating demonstrated an ability to flow with the aluminum in deformation and stress tests. Hammer and chisel blows failed to develop cracking or spalling.

Other advantages claimed for the new plate are:

- Low coefficient of friction
- Uniformity of deposition
- Sapphire-grey color which can be buffed to a high luster
- Reduced possibility of galvanic action

Suggested applications are gears, pumps, valves, flow-metering devices and fasteners.



DC TV: Progress Report

New, more sensitive picture tubes are needed before portable large-screen TV receivers are feasible, according to Texas Instruments Inc. The company recently displayed a 24-transistor, battery-operated set with a 9-in., 70-deg picture tube which is being used to study portable TV design requirements. Greatest problem in applying transistors to larger picture tubes is the increased power required for deflection. If high voltage on the test set is increased from 6.5 kv to 13 kv, and deflection angle from 70 to conventional 110 deg, horizontal-deflection current is boosted from 4 to 30 amp—too high for transistor efficiency.

ARISTOLOY

Electric Furnace Steels

LEADED—Electric Furnace 52100 • Electric Furnace Alloy • Electric Furnace Carbon • Alloy Base Alloy • Alloy Base Carbon

STAINLESS—300 Series • 400 Series • 500 Series

FURNISHED AS—Hot Rolled Blooms, Billets & Bars • Hot Rolled, Annealed & Heat Treated • Ground Blooms & Billets • Bars—Hot Rolled, Turned, Turned, Ground & Polished, or Cold Drawn with or without Heat Treatment

BEARING QUALITY • AIRCRAFT • PISTON PIN QUALITY • ELECTRIC FURNACE ALLOY • ELECTRIC FURNACE CARBON • ALLOY BASE ALLOY • ALLOY BASE CARBON

NEW PRODUCTS & FACILITIES CATALOG

Describes melting, rolling, thermal treating and finishing capacity of Copperweld's Aristoloy Steel Division. Complete product listing for Aristoloy carbon, alloy, stainless, leaded, and nitriding steels. Send for your copy today.

ARISTOLOY STEELS

COPPERWELD STEEL COMPANY

ARISTOLOY STEEL DIVISION • 4017 Mahoning Ave., Warren, Ohio • EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.

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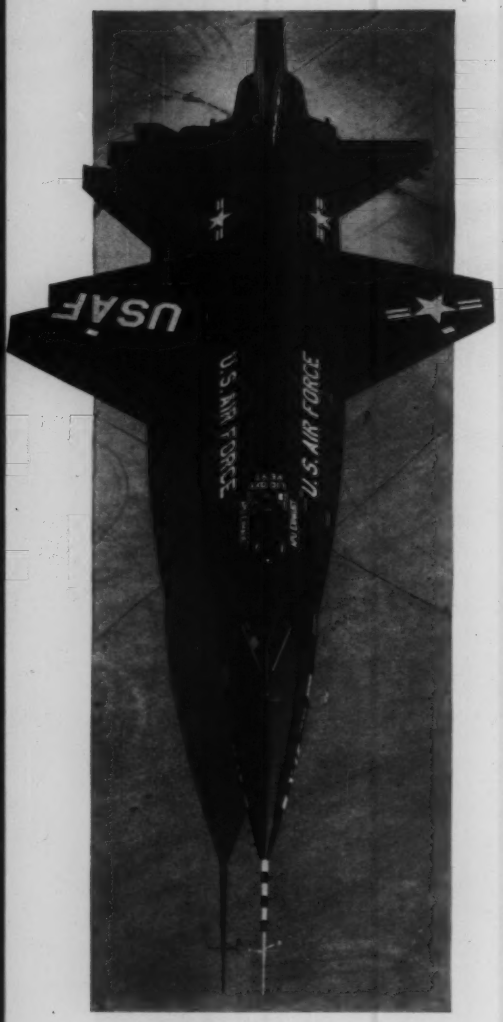


Manned Missile: X-15

Introduced to the public on October 15, North American Aviation's experimental X-15 will make its first air-launched flight into space early next year. The powerful research vehicle, forerunner of orbital bombers, will reach speeds of more than 3600 mph and altitudes of 150 to 300 mi.

Equipped with an inertial guidance system and packed with a pilot and payload of 1300 instruments, X-15 is expected to answer a host of space-age problems. More than 600 temperature pickups will record now unknown data on aerodynamic heating and heat transfer. Strain gages mounted at all strategic locations will measure structural and aerodynamic loads. Since only man can prove how man will react in space, human factors research will gain tremendously important data.

To make certain that X-15 successfully completes its mission in space, engineers have endowed the craft with the newest in materials and design.

An external armor of Inconel X, completely covering X-15, will withstand the expected temperature extremes of −300 to 1200 F. A primary structure of titanium and stainless steel will meet any heat that soaks through the nickel-alloy outer covering. Aluminum is used internally where high heat and high loads are not a problem. Almost 65 per cent of the X-15 is welded structure; 35 per cent fastened. Current operational aircraft are 100 per cent fastened.

First flights of the X-15, scheduled for next February, will utilize two 6000-lb thrust engines. Full-scale space assaults, later in the year, will use the 60,000-lb thrust engine developed especially for X-15 by Reaction Motors Div., Thiokol Chemical Corp. Propellants are LOX and liquid ammonia.

Fuel-flow rate in the powerful engine is 10,000 lb per min, 20 times the flow rate in an F-100 Super Sabre with afterburner. Hydrogen peroxide gas, forced from plastic bladders in spherical stainless-steel pressure tanks, drives the powerful fuel turbopumps.

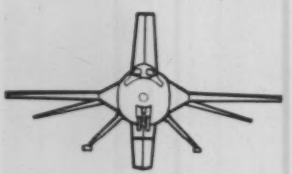
Two separate 3000-psi auxiliary-power units, operating in parallel, and also driven by hydrogen-peroxide pumps, supply electrical and hydraulic power for X-15. Weight of the systems is less than that in the F-100. A 27,000 Btu air-conditioning system that weighs just 150 lb will keep the craft cool.

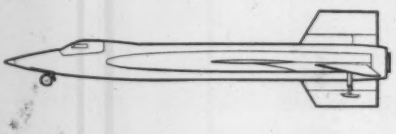
At extreme altitudes, hydrogen-peroxide jets (ballistic-control rockets) mounted on nose and wings will control flight attitude of the X-15. All controls can be wrist-activated by the pilot, since acceleration forces will make arm movement impossible.

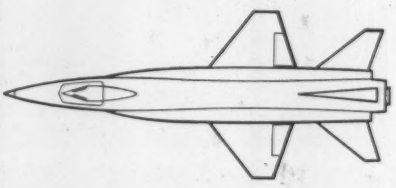
X-15 will land at 275 mph on a dual nose wheel and two steel skids. Prior to setdown, an explosive bolt will blow off a portion of the lower vertical stabilizer that hangs below the landing gear.

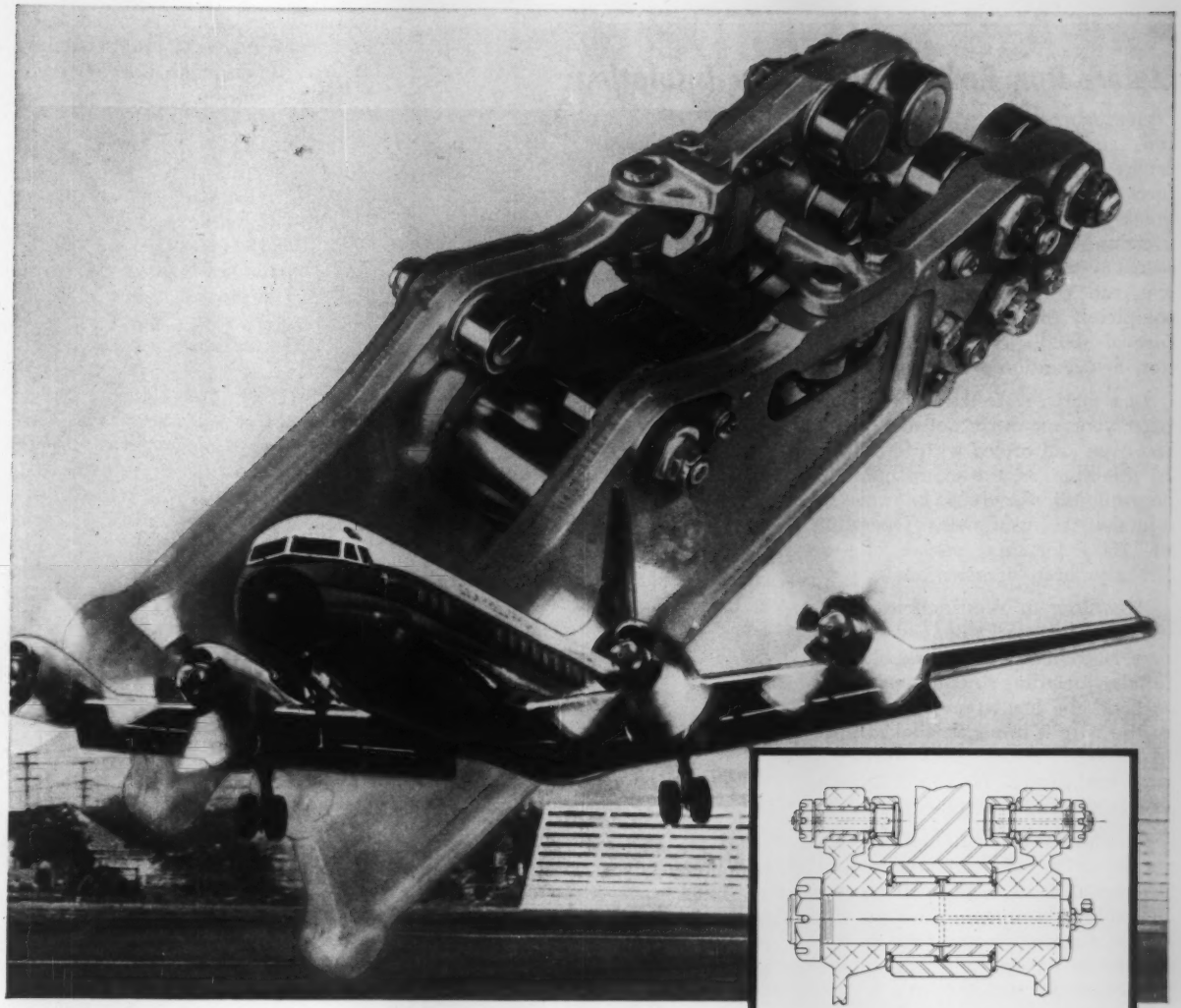
X-15 Dimensions

Wingspan (ft)	22
Wing area (sq ft)	200
Length (ft)	50
Height (ft)	13
Launching weight, (lb)	31,275

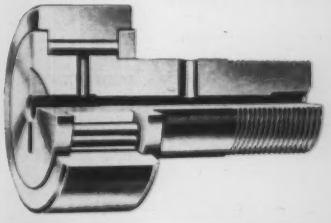








Track roller assembly used on Lockheed Electra (shown in photo above), as well as the C 130-A and Super Constellation, incorporates eight Torrington RT Cam Followers and three Torrington NBF Needle Bearings as track rollers. Portion of assembly is illustrated in above drawing.



Flightweight "champs" of the world...

Torrington Cam Followers

Every fraction of excess weight and size is engineered *out* of the Torrington Type RT Cam Follower to suit it especially for airframe applications.

Designed to run on a hardened steel track, the RT outer race is narrower than that of a standard cam follower needle bearing. The full complement of small diameter rollers assures maximum radial capacity and minimum starting and running friction. The Type RT Cam Follower is mounted with a standard tension nut, and the Type RS with a standard shear nut. All features conserve weight and space.

Type RT and RS Cam Followers are also available in stainless steel for exposed airframe applications. Design, materials, heat treat and finishes meet the highest standards in industry. For further information or application assistance, consult Torrington's engineering department. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • TAPERED ROLLER • SPHERICAL ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS • THRUST

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Motors Run Red Hot with New Insulation

PITTSBURGH — Electric motors that run continuously while glowing bright red in 1200-F temperatures demonstrate a spectacular breakthrough in insulation at Westinghouse Research Laboratory. In recent tests, a 5-hp, 110-v ac motor was run continuously for 100 hr completely immersed in a temperature of 950 F. No signs of insulation deterioration were found.

In a more severe test, motor bearings were mounted outside of the test oven and cooled with forced air. In this manner, the motor operated continuously for 1000 hr with no damage to insulation. Operation at 1200 F for short periods of time has also been demonstrated.

According to Westinghouse engineers, the remarkable new insulation is composed of inorganic materials, including inorganic binders to bond the insulation permanently to the wire it protects. Flaked mica in various solutions and slurries is used extensively. No plastics, cloth, or other organic substances are used.

In addition to insulation for wire, the material has been prepared experimentally in flexible sheets and in laminated form. Thermal life of the material in any form is considered to be indefinite at temperatures ranging to 950 F.

Motors used in the testing program are obviously of special construction. Silver wire is used for windings, since copper would oxidize at the extreme temperatures and become useless as a conductor. Motor frame and end bells are Ni-Resist iron, heat treated to provide the best dimensional stability possible at high temperatures. Bearings are graphite and have operated successfully for over 100 hr at 1000 F.

Applications for the new insulation will be extended to relays, transformers, solenoids, and many other electrical components — wherever high heat is a problem.

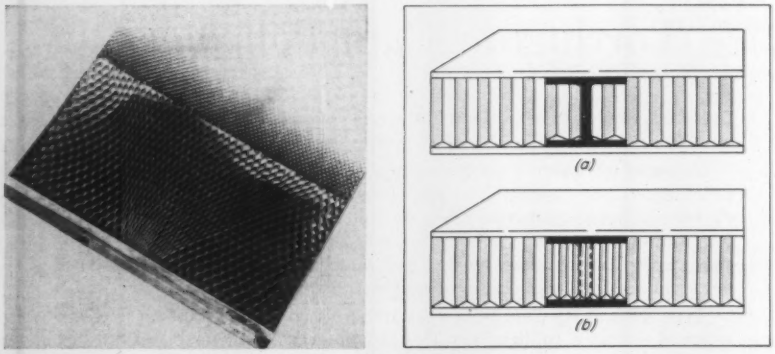
New insulation developed by Westinghouse enables this electric motor to perform useful work for extended periods of time while broiling in the flames of a gas jet.

Dense-Core Load Paths Raise Honeycomb Panel Strength

Stress Paths Molded or Crushed-in at Assembly

LOS ANGELES—Dense core paths to carry high loads in honeycomb panels have been successfully formed by molding or crushing the honeycomb core in a pattern roughly corresponding to the major stress flow in the panel. This avoids internal fasteners and special brazing which means lighter weight and economy. Where desirable, such paths are brazed as a separate subassembly.

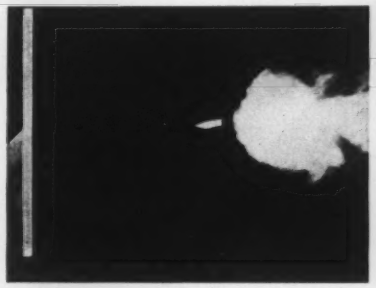
Patches of smaller cell or heavier gage foil are also inserted where necessary. Since a certain amount of splicing is needed to make up a core blanket, this technique adds little to the cost. Where the core is tapered, as in the edges of some airfoils, adding a smaller cell core at the edge allows the core blanket to be feathered to a fairly sharp edge while still providing a high degree of skin stabilization. Small



Dense-core stress path molded into honeycomb panel, left, supports concentrated load applied at panel edge. Sketches of panel sections, right, show technique for replacing buried I-beam, a, by skin doublers and dense core, b. Denser core area serves as "beam" web.

localized areas of high stress around fasteners and at edges of joining members are similarly treated by splicing in a dense core section.

The technique is also applied to the problem of providing a structural spar through a sandwich panel. Mr. Floyd F. Rechlin of Solar Aircraft Co. pointed out in a recent SAE paper that traditionally an I-beam has been employed in such a location. However, it is costly and difficult to hold the height of an I-beam cross section to the tolerances needed for a honeycomb panel (±0.003 in.), and it would be next to impossible to guarantee a shear tie between the web of the I-beam and the honeycomb core. A solution is the use of doubler strips to correspond to the caps of the spar, and a dense-core area to correspond to the web.

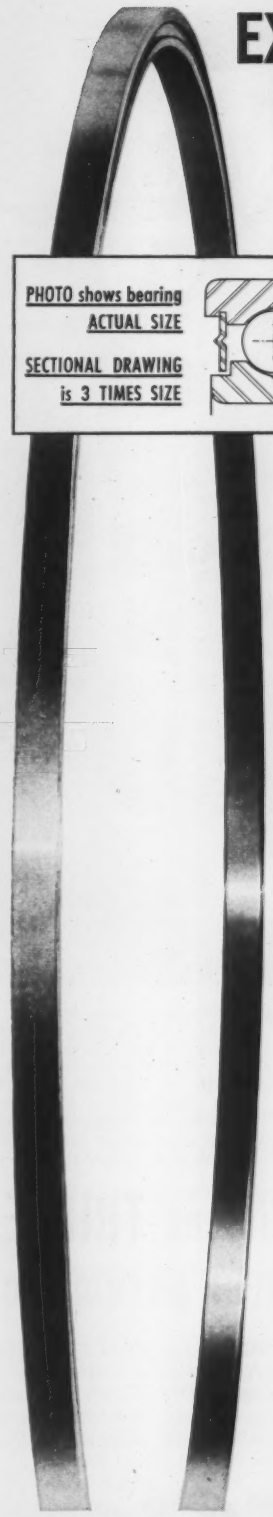


Plastic Defies Bullet

Glass-cloth laminate only 5/16 in. thick withstands impact from a 38-cal bullet fired from a distance of 30 in. Only a lead mark which can be wiped away with solvent is apparent as a result. The bullet is fired in a path normal to the plane of the plastic and is traveling at 800 fps. The panel was laminated with Hysol epoxys developed by Houghton Laboratories Inc., Olean, N. Y.

Auto Bumpers Lose Weight

Aluminum bumpers may make a considerable impact on the automobile industry in the near future, according to Aluminum Co. of America. Contemporary front bumpers fabricated from heavier metals weigh from 50 to 150 lb. Aluminum bumper-grille combinations, weighing half as much, would improve handling, steering, and tire life, with no loss in impact-absorption capacity.

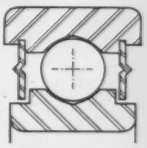


EXTRA-THIN BEARING WITH BUILT-IN SHIELDS

- SAVES SPACE
- SIMPLIFIES ASSEMBLY
- CUTS MAINTENANCE COST

PHOTO shows bearing ACTUAL SIZE

SECTIONAL DRAWING is 3 TIMES SIZE



SIZE: 10.500" OD; 0.270" wide; 0.250" thick.
BALL DIAMETER: 0.125" ±.000025".
MATERIALS: Stainless steel.
MAXIMUM RUNOUT OF OUTER RACE: 0.0002" TIR.
STATIC LOAD CAPACITY: Radial, 4,630 lb.; axial, 13,200 lb.
TORQUE: 5 to 6 inch-ounces at 100 lb. axial load.

Standard bearings often impose limitations on production economy and freedom of design. These restrictions are often eliminated by *special* bearings, custom-engineered by ITI. For example —

To save space, simplify assembly and prevent operating trouble, we designed and are producing this extra-thin-section ball bearing, equipped with a built-in shield on each side in place of separate shields. The shields fit so closely that they retain the lubricant and enable the bearing to pass the standard military sand and dust storm test. This construction assures long-lived low-torque operation, and cuts both assembly and maintenance costs.

YOUR design problem might likewise be simplified or your product improved by ball or roller bearings of special section or configuration, heat resistance, corrosion resistance, ultra precision, or other unusual properties. We design and produce such bearings to individual requirements, in any size from ¼" ID to over 70" OD; and we invite your inquiries.

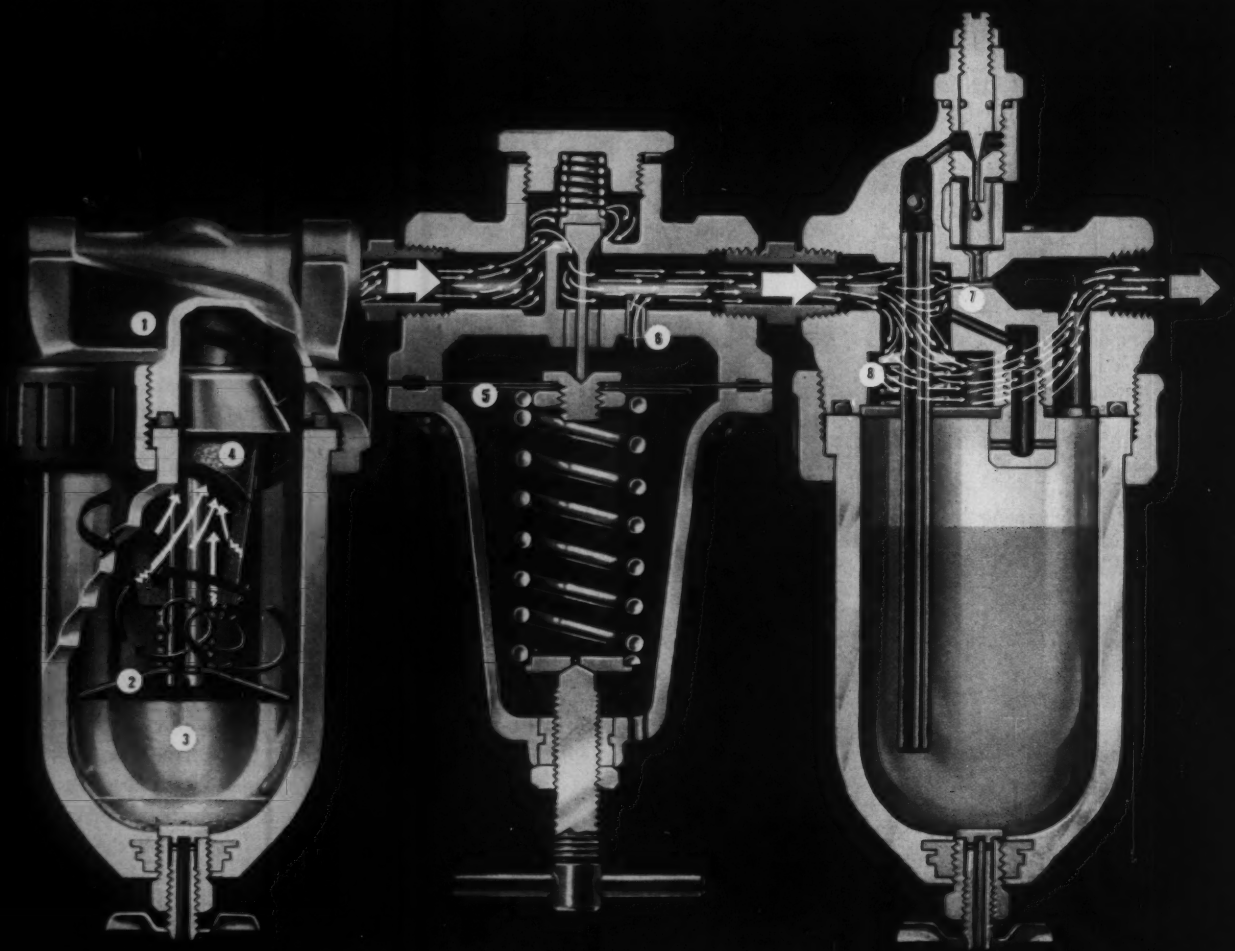
FREE BULLETIN AFB-2 describes our work in this field — shows a wide variety of "specials" — tells about factors involved in special bearing applications. Write for it!

INDUSTRIAL TECTONICS, Inc.

MANUFACTURERS OF PRECISION BALLS AND BEARINGS

3689 JACKSON RD., ANN ARBOR, MICH.

WESTERN DIVISION PLANT: COMPTON, CALIFORNIA



Curved inlet ❶ directs incoming air in downward helical pattern. Larger impurities and condensate are "thrown out" by centrifugal action, collecting on bowl sides and spiraling downward past baffle ❷ into quiet chamber for draining off. Baffle traps sediment in quiet chamber ❸ and allows only dry air centrifugally cleaned of larger impurities to reach porous bronze filter element ❹ where finer particles are filtered out.

Diaphragm of large area ❺ is of BUNA-N—imparts extra sensitivity for response to even minute reduced pressure variations. Aspirator ❻ acts directly on diaphragm, providing instant compensation for fluctuating loads . . . assures precise control and stabilizes pressures reaching individual pieces of equipment.

High velocity venturi section ❼ provides ultra-fine, enduring atomization at air flow rates even less than 1 CFM. An exclusive by-pass feature ❽ provides lubrication at high flow rate without excessive pressure drop—wide range performance in **one unit.** Proof of lubricating efficiency assured because **all** visible metered oil is atomized.

NOW! Get this efficient TRIPLE LIFE-GUARD protection for your pneumatic equipment

A continuous supply of clean dry air . . . at a constant pressure . . . with just the right amount of lubrication provided at points of friction and wear. Air-operated equipment requires this three-way protection today; the Watts combination of pneumatic controls *assures* it.

You can expect *high efficiency* from the Watts line of advanced-design air line filters, regulators, and "Perma-Fog" lubricators. It's the *quality* assembly. Specialists in protection and control devices since 1875, Watts is setting new *standards* of efficiency in pneumatic operation.

WATTS

FILTERS
REGULATORS
LUBRICATORS

YOUR SAFE PROTECTION

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Watts Regulator Company—Industrial Division—8 Embankment Road—Lawrence, Massachusetts

It's a technical bulletin as well as catalog, describing the complete line of Watts Pneumatic Products. Complete engineering and operational data is furnished so that each page is, in fact, a specification sheet. Saves valuable time for the designer.

Reader Information Service

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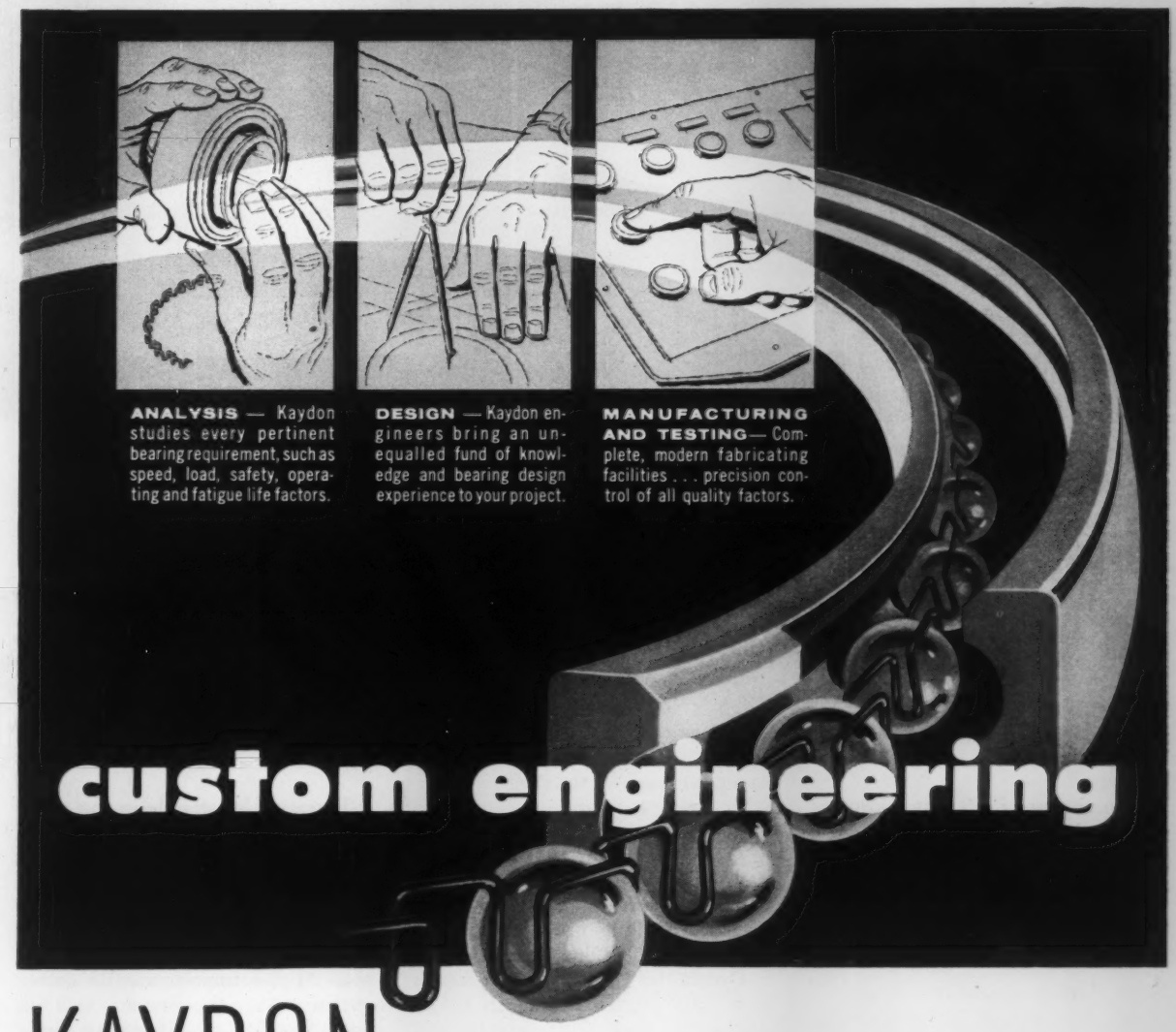

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Why penalize product performance success with "make-do" bearings? Kaydon's long experience points out that standard bearings often *won't do*, aren't always efficient or economical.

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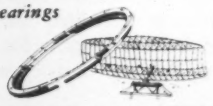

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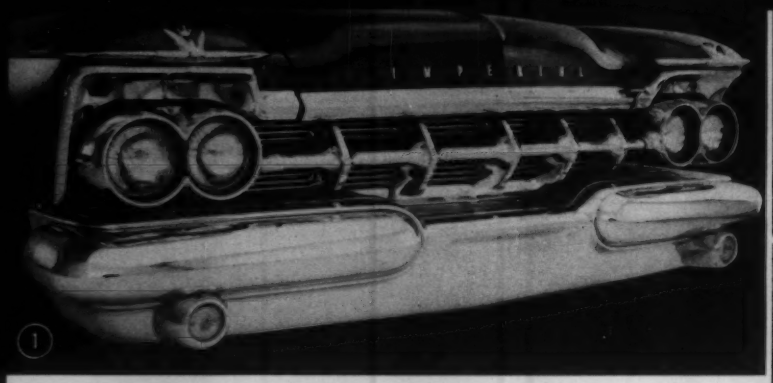

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1. Imperial
2. Chrysler
3. Lark
4. Silver Hawk
5. Plymouth
6. DeSoto
7. Dodge

High-styled power: the '59s

part 2

The survey of '59 cars continues in this issue with a look at new engineering features incorporated in the Chrysler and Studebaker-Packard lines.

On the over-all scene, these facts and figures were making news:

Sales (Up)

If public acceptance of new cars continues near the present rate, the U. S. will ride out of the recession with power to spare.

Buick, for example, reports sales of 37,500 cars during the first 10 days—a new company record. The company further disclosed that orders are piling up 4 to 5 weeks ahead of production.

Orders for Studebaker-Packard's new Lark started rolling in before the car hit dealers' showrooms, and initial sales are admittedly running ahead of company anticipation.

People are still looking for new accessories, according to Dodge. Swivel seats have been specified in more than 45 per cent of new-car orders received to date.

5

Size (Controversy: Cont'd)

In St. Louis, six downtown parking lots are turning away customers with Cadillacs. The '59 models are too long for their ramps. Other new cars that grew longer this year may join the outcasts.

There is also trouble at the other end of the spectrum. A recent study by the Bureau of Public Roads, Dept. of Commerce, states that small European cars take up as much, if not more, of the road than standard American models. Low seats in the imports impair driver visibility, says the Bureau, and because the driver can't see far ahead he lags behind the car in front. Also, some low-powered European cars are relatively poor hill climbers, and thus widen gaps in traffic at every steep grade.

Engineering (Fine Points)

A current advertisement for Rolls Royce exclaims that at 70 mph the loudest audible sound in the car is the ticking of the clock. In this country, Chrysler ran into a similar, though less dignified problem in testing the new engine for their '59 models. The air cleaner was noisy.

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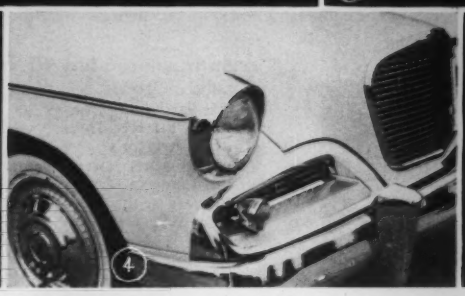
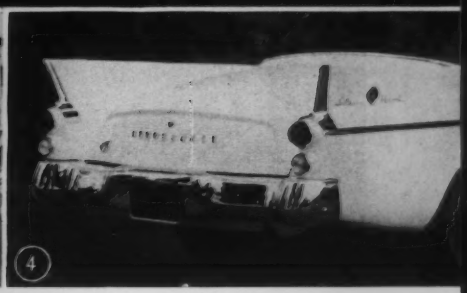
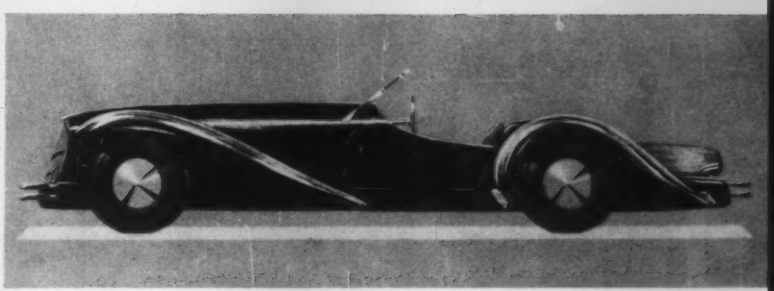






A research program was instituted, and the result is an engine with a scientifically tuned air cleaner. The chamber is used as a resonator to which the air-intake snorkel is tuned. Air-cleaner noises in the high-frequency range are completely eliminated; noises in the medium and low-frequency ranges are substantially subdued. The project involved miles of driving and tape recordings.

Future (The People's Choice)

As everyone knows, designs of the '59 cars were completed and "frozen" two years ago. This is a billion dollar gamble: Detroit vs. the whim of the people. Detroit stays on top because it leaves nothing to mere chance in striving to understand the nature, needs, and desires of its customers.

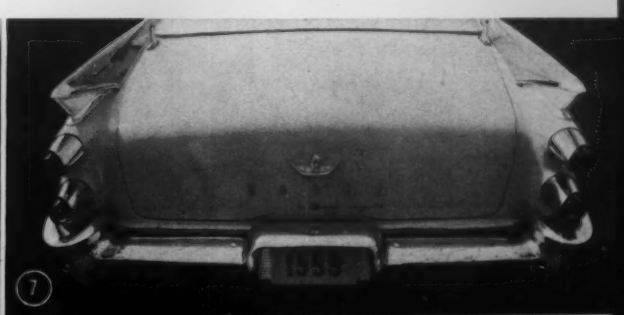
A new and unique approach with a definite personal touch was completed recently by Ford. With the help of the Gallup organization, Ford selected 400 persons from 400 different U. S. cities to attend a consumer conference in Detroit. The panelists and Ford executives informally discussed all phases of the auto industry. At the conclusion of the meeting, panel members were assigned '59 Fords for a month-long testing program. Results of the meeting may appear in 2 years.

Darkhorse (Thoroughbred)

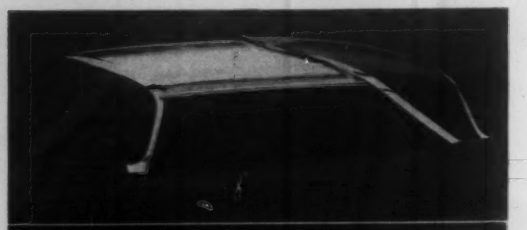
At a quiet press conference in Cleveland last week, the Argonaut Motor Car Corp. displayed the engine and chassis that will fit under America's newest, biggest, and most expensive car ($17,000 to $20,000 plus). Pictured above is an artist's rendition of the Texan, one of Argonaut's seven custom body styles. Bodies for all models will be handcrafted of aluminum in Italy, and chassis will be shipped to that country for final assembly.

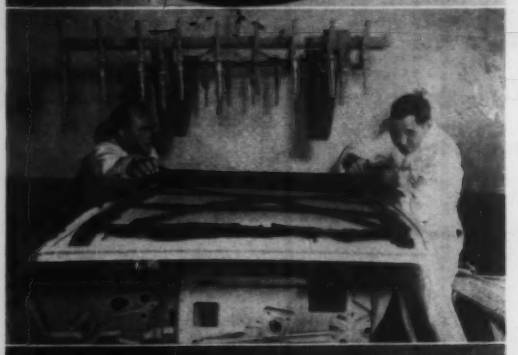
Argonaut's frame is fabricated from 5 in. seamless-steel tubing, with a wall thickness of 3/16 in. Weight distribution is 50-50, and the center of gravity is claimed to be lower than on any other car in the world. Fuel tank, hydraulic brake lines, muffler, and exhaust system are polished stainless steel. Brakes have flanges for air cooling and use sintered-iron linings. Front and rear shocks are individually adjustable. In addition to the normal complement of instruments and gages, Argonaut has a tachometer, altimeter, chronometer, and oil-temperature gage.

Engine specifications were not disclosed by Argonaut's builders. They describe it only as having extremely high horsepower.

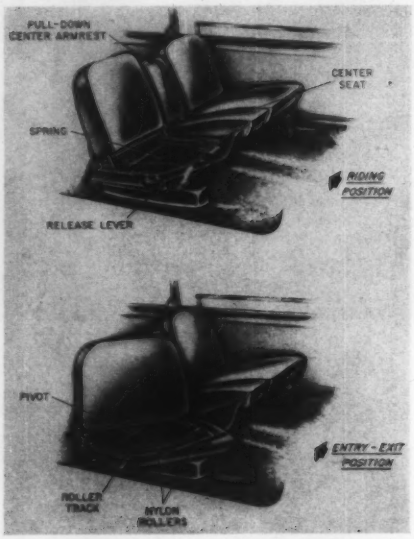


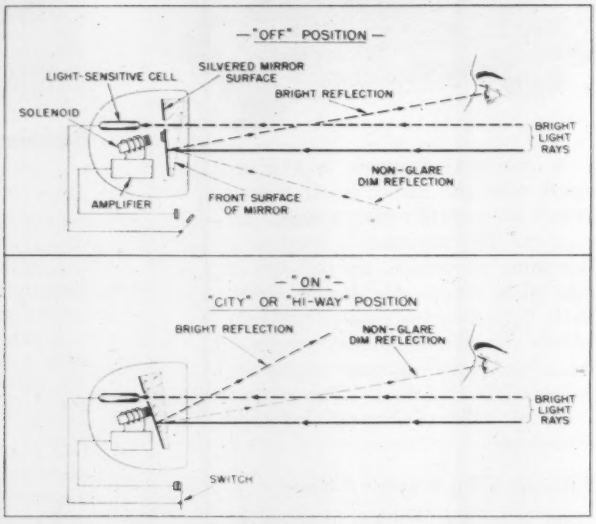
Chrysler line, '59: Swivel seats, electronic mirror, stainless-steel top . . .





Spring - loaded swivel seats are standard or optional on all five lines of Chrysler's '59 cars. Seats swing outward in a 40-deg arc at the press of a lever, lock in place when returned to normal position. Two nylon rollers housed firmly in a swivel track, and a heavy bolt at the pivot point anchor the seat securely to the seat frame.





For the man who has everything: An electronic, self-dimming rearview mirror is a new Chrysler option. The self-contained unit is powered by a photoelectric cell which "sees" through a small aperture in the silvered mirror surface. When light intensity becomes high enough to cause annoying glare, current generated by the cell activates a miniature amplifier and solenoid assembly, flipping the mirror prism a few degrees upward. Mirror returns to normal position when light intensity drops below a preset level. A three-position switch on the mirror frame has an off position for daytime driving, a city position so the mirror won't respond to street lights and neon signs, and a maximum sensitivity hi-way position.

Stainless-steel roof on Imperial hardtops is a custom feature, largely hand-crafted. Adhesive cement is applied to the normal rooftop, a sound-dampening layer of Osnaburg cloth is laid on, the stainless cap is properly positioned, and 20 stainless-steel draw rivets are inserted and trimmed. One version of the top, the Silvercrest Landau, has the brushed stainless cap forward of the Landau step, with rear roof finished in a contrasting textured vinyl paint to simulate black, grained leather.

Imperial

ENGINE: Powerplant redesign increases displacement from 392 to 413 cu in. Power is up slightly—from 345 to 350 hp. The new engine features a deep-skirted block and in-line overhead valves with hydraulic lifters. Coolant capacity has been reduced from 25 to 16 qt, which means faster warmup and better economy on short-trip driving.

BODY-FRAME: Over-all dimensions are largely unchanged. The frame has been considerably strengthened by use of heavier gage steel. Stainless-steel roofs are optional on hardtop models.

ACCESSORIES: Electronic self-dimming rearview mirror, swivel front seats, pushbutton-controlled heater-air conditioner, and rear air suspension are new and optional this year.

Chrysler

ENGINE: Two new powerplants that displace 383 and 413 cu in. replace last year's 354 and 394-cu in. engines. Power ratings range from 305 to 380 hp vs. 290 to 345 hp last year. Engine weight has been reduced by 100 lb (an 8-qt reduction in coolant accounts for 18 lb).

BODY-FRAME: Rear seats of four-door hardtops have been raised about 2 in. for greater comfort. Roofs have been raised accordingly. Two-tone exterior roof styling is new.

ACCESSORIES: Same as Imperial.

DeSoto

ENGINE: Last year's biggest engine, 361 cu in., is this year's smallest. The new 383 cu in. engine, offered on Firedome and Fireflite series, rates 305 to 325 hp, depending on carburetion. The 350-hp Adventurer engine is optional.

BODY-FRAME: Over-all dimensions are largely unchanged.

SUSPENSION: Rear air suspension combined with metal leaf springs is new and optional.

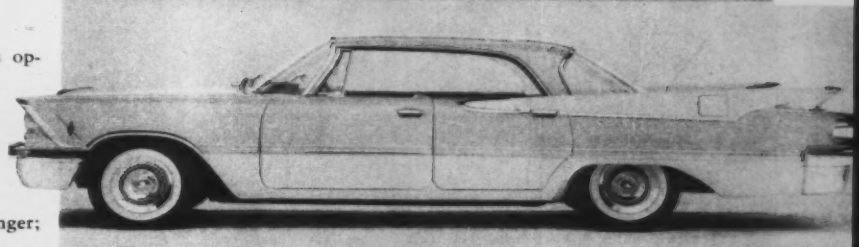
ACCESSORIES: Swivel seats and electronic rearview mirror are optional on all models.

Dodge

ENGINE: Chrysler's 383 cu in. engine is optionally available on all models as a regular and super "D-500" package. Power ratings are 305 and 325 hp, depending on carburetion and other modifications. Standard in Coronets is a 230-cu-in. L-head six, same as last year, or a 326 cu in. V-8 rated at 255 hp. Royal and custom series are fitted with a 361 cu in., 285-hp engine.

BODY-FRAME: Bodies are 3.5 in. longer; other dimensions are about the same.

ACCESSORIES: Swivel seats, rear air suspension, electronic rearview mirror, and electronic headlight dimmer are new options.



Plymouth

ENGINE: Displacement of the optional Golden Commando V-8 has been increased from 350 to 361 cu in. by increasing the bore 0.06 in. Power rating, 305 hp, is unchanged. Standard Engines—a six and V-8—are largely unchanged. A variety of rear axle gear ratios are available with all engines, including a 2.93 to 1 ratio which reportedly reduces fuel consumption of V-8's by 6 per cent.

BODY-FRAME: Over-all length has been increased about 3.5 in.

ACCESSORIES: Same as Dodge plus a gasoline-fired heater.

Studebaker-Packard: A brand-new car for a growing demand . . .

Lark

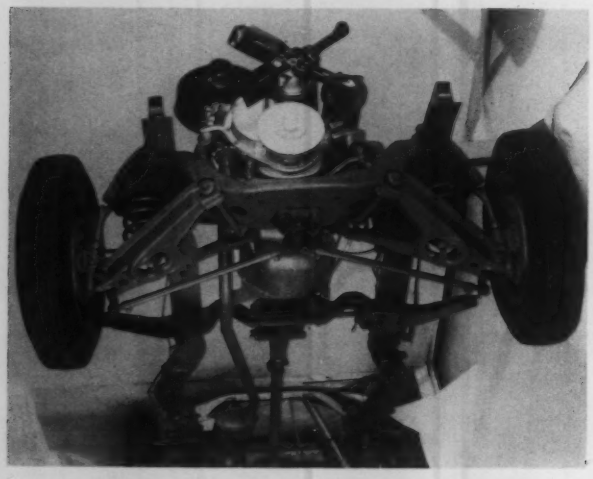
Silver Hawk

ENGINES: A six and V-8 are offered on both cars. The V-8 is a slightly modified '58 Commander engine with a compression ratio of 8.8 to 1 vs. 8 to 1 last year. Power rating remains the same at 180 hp. The six-cylinder engine, completely redesigned, is smaller this year. The same over-all car performance is claimed for the new engine, however, with up to 20 per cent better fuel economy. Bore has been reduced 0.37 in. to an even 4 in., and displacement is down from 185.6 to 169.6 cu in. Compression ratio has been raised from 7.8 to 1 to 8.3 to 1. The engine develops 90 hp at 4000 rpm compared to last year's 101 hp at 4400 rpm.

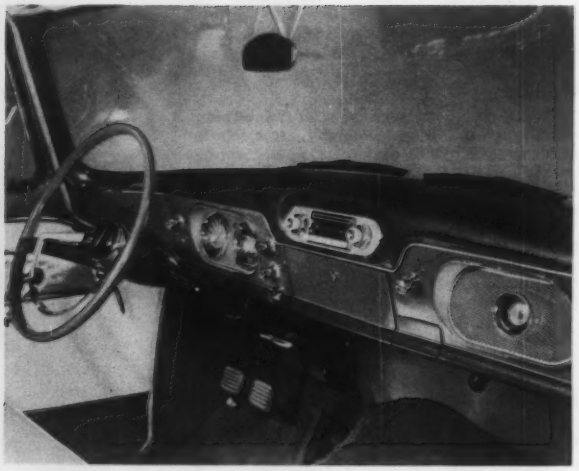
BODY-FRAME: Silver Hawk dimensions are largely unchanged. The Lark, on a 108.5-in. wheelbase, is offered in two series, Regal and Deluxe, with four body styles in each series: two and four-door sedans, two-door hardtops, and station wagons. Over-all length of sedan models is 175-in., width is 69 in., and height 57.5 in. (Nash Rambler American has a 120-in. wheelbase and is 178 in. long.) Lark is mounted on a modified Hawk frame—the structure was shortened and strengthened. Front and rear fender panels are removable, a cost saving feature in event of collision.

ACCESSORIES: Reclining seats, non-slip differential, and power brakes are optional equipment. Both Lark and Hawk can be equipped with conventional, overdrive, or automatic transmission.

S-P design keynotes: Ruggedness, economy, style . . .

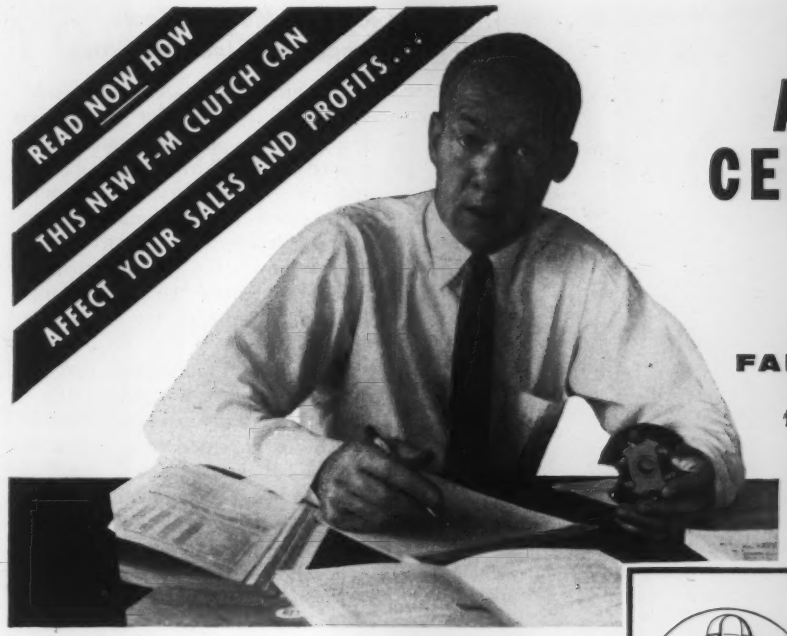


Frame and suspension for the Lark are modified Hawk components. The longer Hawk frame was chopped, and strengthened, to fit under the smaller car. Variable rate coil springs were redesigned to give a more stable ride under all load conditions.



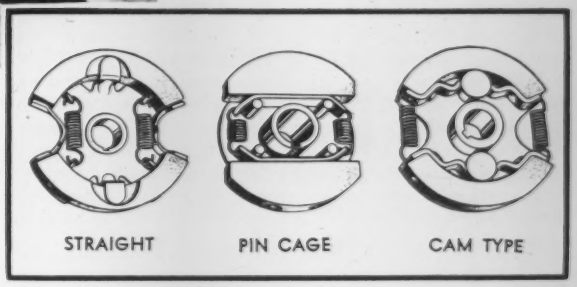
Lark interior, Regal series, features padded instrument panel as standard equipment. With economy a keynote, interior styling makes use of a single basic fabric pattern in one of four color schemes. Exterior finish is limited to a selection of seven solid colors.

READ NOW HOW THIS NEW F-M CLUTCH CAN AFFECT YOUR SALES AND PROFITS . . .



A NEW AUTOMATIC CENTRIFUGAL CLUTCH

designed by FAIRBANKS-MORSE for the toughest usage you can name



Substantial cost savings for companies who can use it!

Here's an idea for engineers who want to reduce costs for profit improvement.

Simple design and high-volume production of these new clutches for motors and small gasoline engines mean substantial savings to you. And your quantity requirements make little difference in the cost.

If your equipment does not incorporate this starting feature, think of the benefits. Smaller motors can be used for *running* rather than starting loads. It provides low-line voltage protection on jobs where transmission lines are not adequate. You get smooth, gradual pick-up, and the motor is never called on to deliver power below its maximum torque speed. Starting current demand is reduced. It's a foolproof safety device — protects against stalling or overloads, yet does not slip at operating speed.

Gasoline engines may be started easier. The load is automatically applied at the engine's most efficient speed. It prevents stalling and accidental equipment damage.

The new clutch is manufactured in three types — all can be used with a pulley, sprocket, gear, or coupling-type drive on machinery, appliances, and gasoline engine equipment — any application on which automatic start and stop applies. If you already make or buy clutches, couplings, or drives for no-load starting and idling or overload protection, write for Fairbanks-Morse prices and evaluate the cost savings.

- **Simple and dependable—only four moving parts**
- **Compact, no-maintenance design**
- **Proved long life on chain saws**
- **Operates in either direction**
- **Mounts in any position, as clutch or sheave**
- **Smooth, low- or high-speed actuation**
- **Economy of mass production**
- **Prevents overloads, shock, and engine pulsations**
- **Smaller motors can be used**
- **Smaller clutch can be used at motor than at jackshaft**
- **No slip at normal operating speeds**

Send coupon and application data, we'll send literature, recommendations, and prices.

Fairbanks, Morse & Co., Magneto Division
Beloit, Wisconsin

☐ Please send literature on automatic clutches.

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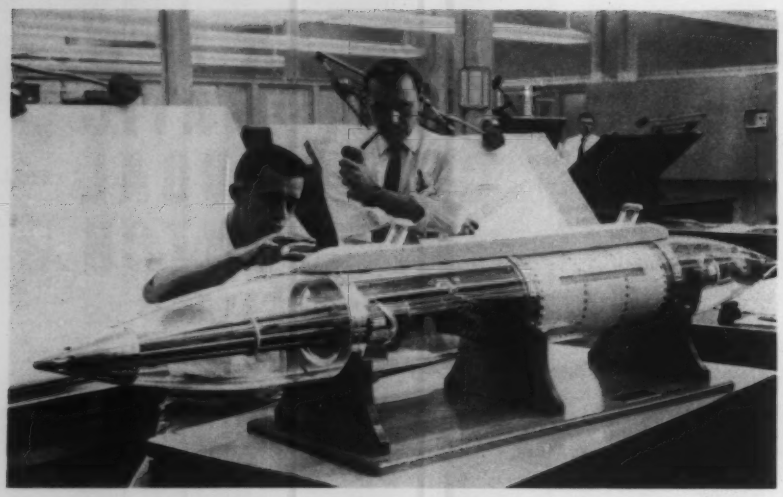
Circle 414 on Page 19



Pass the Ammunition . . . a Ton a Minute

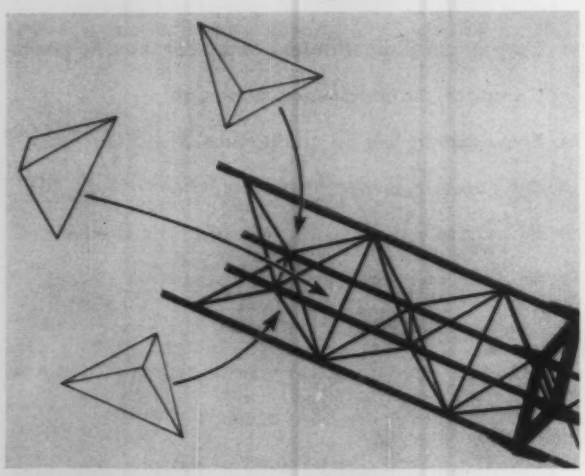
Almost a solid stream of lead spews from a new eight-barrel Army machine gun. It's a powerful new version of the Civil War Gatling gun and fires 6000 to 10,000 rounds of 7.62-mm (NATO standard) ammunition per min. The gun was developed for Army Ordnance by General Electric Co. and is similar to GE's 20-mm Vulcan aircraft cannon which arms several new jet aircraft, including the F-104, F-105, and B-58. The smaller weapon uses a linkless ammunition feed system, and electric and hydraulic power replace Gatling's hand crank. Weight of the gun is just 185 lb, and it fits into a bullet-shape container 90 in. long by 10 in. in diam. Army has not disclosed whether the new Gatling will be used as aircraft armament or be vehicle mounted. Adequate fire-control systems are required in either case, since it can shoot a ton of ammunition a minute.

Modular Machine Tools Proposed by Industry Group

DEARBORN, MICH.—A new "building block" concept for the design of production machine tools—developed by Ford Motor Co. in conjunction with Chrysler, General Motors, and International Harvester—has won the support of 15 major manufacturing concerns, according to Ford's Henry C. Daum, chairman of an industry study committee.

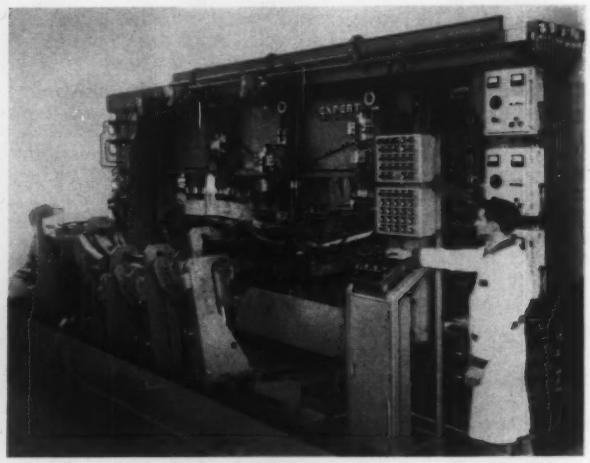
Mr. Daum emphasized that industrial users are not attempting to dictate design features to machine-tool builders, since only a limited number of standardized specifications are being recommended. Some tool manufacturers now produce machines with standard dimensions; however, each builder's standards are usually applicable only to his own products.

"Until recently," said Mr. Daum, "it appeared that automation with its enormous investment in equipment might tend to freeze design in the automobile industry. The large transfer machines . . . have



Tetrahedrons Stiffen Long Boom

Whipping and bending during load pickup and swing are virtually eliminated in long crane booms by a new structural design. Basic figure in the boom is the tetrahedron—a polyhedron with four triangular faces. Boom and jibs up to 200 ft long are fully braced against loads in every direction by the rigid structure. In the boom illustrated—which measures 44 in. on a side—main chord members (square sections) and cross bracings (round sections) are high-strength alloy-steel tubing. Designed by Link-Belt Speeder Corp., Cedar Rapids, Iowa, for its line of 30 to 40-ton lifting cranes, the new boom structure adds 20 to 60 ft in usable height to former crane-boom assemblies.

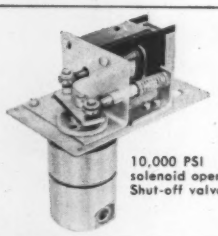


Tape Stores Welder Errors

A new tape-controlled welding machine automatically joins metal parts having untrimmed, out-of-tolerance, straight line, or contour weld-line edges. A mechanical probe mounted on the welding head carriage traces the weld contour, and probe movements are transmitted to a differential whose output represents error between the actual and the design weld line. This error is recorded and stored on magnetic tape. A reading head picks up the error and feeds it through an amplifier to a servo cylinder which then corrects head position with respect to the welding carriage. The machine was designed by Expert Die & Tool Co., Detroit.

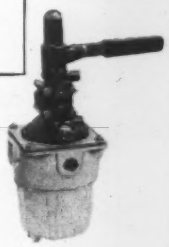
YOUR **SPECIAL** VALVE

MAY ALREADY BE **IN PRODUCTION**



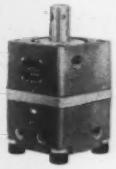
10,000 PSI solenoid operated Shut-off valve.

250 PSI 4-way spring centered miniature manual non inter-flow valve.

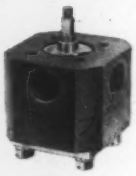


3000 PSI 3-way explosion-proof solenoid valve with manual override.

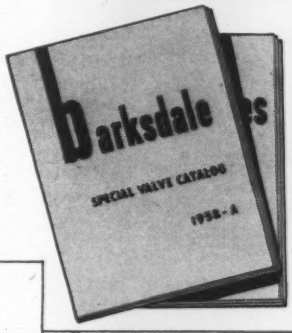
3000 PSI inline manual shut-off valve.



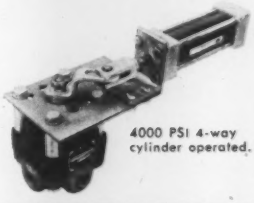
3000 PSI Dual 3-way, 3-position manual non inter-flow valve.



3000 PSI 4-way non inter-flow manual valve built to military specifications.

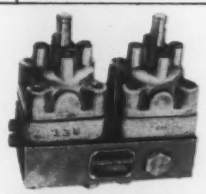


1500 PSI 4-way spring centered manual valve with built in cylinder relief and pressure relief valves.



4000 PSI 4-way cylinder operated.

1500 PSI 4-way spring centered manual valve with built in cylinder relief valve.



1500 PSI manifold mounted manual valves on a sub base with built in check and relief valves.

The Barksdale valves shown on this page represent some of the over 1000 typical examples of modifications developed for the special requirements of original equipment manufacturers.

We are interested in "Specials" and can produce them economically, because the "Shear-Seal" design is exceptionally adaptable.

If you have a special valve requirement, call your Barksdale representative and ask to see the scores of existing modifications in Special Valve Catalog SV-158 and Remote Control Catalog RV-958, or write and outline your special requirements to:

CONTROL VALVE DIVISION

Barksdale valves

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TO FIND THE BARKSDALE REPRESENTATIVE IN YOUR AREA LOOK UNDER "VALVES" IN THE CLASSIFIED SECTION OF THE FOLLOWING PHONE BOOKS:

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Rockford
Rock Island
Indiana, Indianapolis
Iowa, Davenport
Kansas, Wichita
Louisiana, New Orleans
Maryland, Baltimore
Massachusetts, Boston
Michigan, Detroit
Minnesota, Minneapolis
St. Paul
Missouri, St. Louis
Kansas City
New Jersey, Jersey City
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Manhattan
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Cleveland
Oklahoma, Tulsa
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Pennsylvania, Philadelphia
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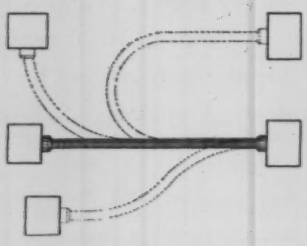
Tennessee, Memphis
Texas, Amarillo
El Paso
Houston
Washington, Seattle
Wisconsin, Milwaukee

Circle 415 on Page 19

(Advertisement)

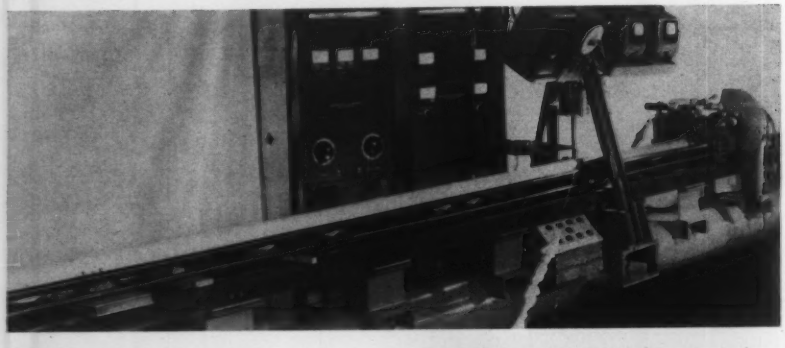
FLEXIBLE SHAFTING OFFERS NEW FREEDOM OF DESIGN

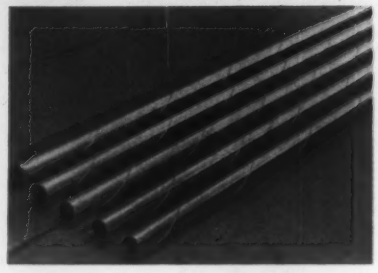


Before the innovation of Flexible Shafting, it was necessary to transmit power from a drive unit to its driven unit by means of a solid shaft which utilized expensive and cumbrous gearing. Today the Flexible Shaft alone provides a means of transferring this power from one unit to another by going around, over, and under obstacles. This allows you more space in your design, and eliminates the age old problem of having to have perfect alignment of the shaft and its drive or driven unit in order to make a connection. Flexible Shafts are simply curved towards the unit and connected by means of a ferrule, or an end fitting. If you have any application, now or in the future, which will require control from remote places, you owe it to yourself to write F. W. Stewart Corporation, 4311 Ravenswood Ave., Chicago 13, Illinois, for complete information on Circle Ess Flexible Shafting.

been highly specialized and difficult to adapt to changes in model and design."

Ford points out that the "building block" concept would encourage incorporation of design changes, since flexibility of equipment will make such changes less costly.





Welding with Sound

Spiral aluminum ribs are "stitch welded" to 15-ft aluminum tubes by an ultrasonic welder developed by Aeroprojects Inc., West Chester, Pa. Effect of a continuous weld is produced by overlapping a series of individual spot welds. The entire operation is automatic, including indexing the tube, locating the rib, spacing the spot welds, and cycling the actual weld.

Mild Steel with New Coat Is Comparable to Stainless

Furnace-Bonded Coating Resists Oxidation, Abrasion

DETROIT—Corrosion resistance comparable to that of stainless steel is possible for mild steel using a new furnace-bonded coating which resists abrasion and corrosion. The new process is readily applicable to thin sections, such as formed members and sheet metal parts, as well as to other nonmachined components. Because it is applied following fabrication, the coating gives complete protection—unlike clad materials where joints and edges are unprotected because of machining.

Three high-nickel-base alloys designated Nicrocoat No. 1, No. 2, and No. 3, are furnished in powder form mixed with a vehicle for spraying, dipping, or brushing. Thickness of applied coat varies from 0.002 in. to 0.010 in., depending on thickness of base metal and anticipated service requirements. Bonding temperatures vary from 2150 F for alloy No. 1, to 1800 F for alloy No. 3, which is especially designed for use with light sections. Manufacturer is Wall Colmonoy Corp., Detroit.

Modern Man Not Obsolete Says Man-Machine Specialist

Is Short on Memory, Long on Judgment

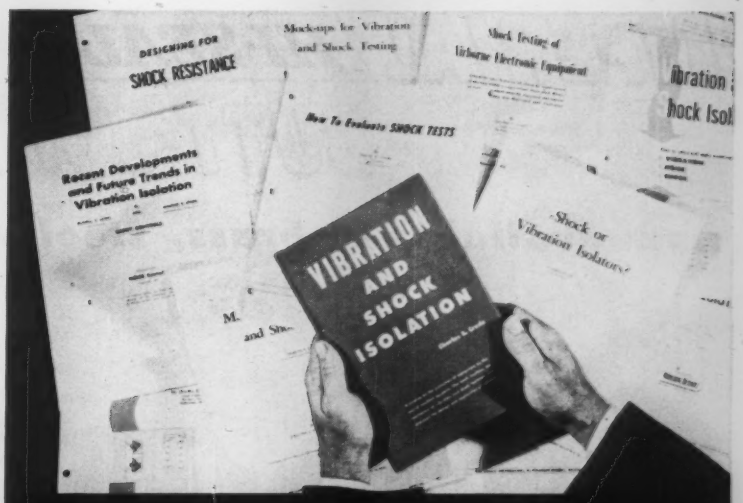
ANN ARBOR, MICH. — Pushbuttons will not dominate tomorrow's world, says a University of Michigan specialist on man-machine systems. While more of man's work will become automated in the future, the combination of men and machines is more economical, efficient, and safe than either one alone in many complex tasks, according to Prof. Paul M. Fitts.

He based this conclusion on several years' work designing improved systems for air traffic control. He outlined some of his general findings

Circle 416 on Page 19

VIBRATION and SHOCK CONTROL *thru design*

a TEAM* project


DESIGNING FOR
SHOCK RESISTANCE
Mock-ups for Vibration and Shock Testing
Shock Testing of Airborne Electronic Equipment
How To Evaluate SHOCK TESTS
Recent Developments and Future Trends in Vibration Isolation
VIBRATION AND SHOCK ISOLATION
Shock or Vibration Isolators?

COLLINS RADIO CO.
hired the engineering team *that wrote the book*
. . . and here's the result

* *Techniques of Energy Absorption and Modification*

In this typical TEAM* project, engineers of Collins and the airframe manufacturer specified the performance of a support for a 180-pound "integrated electronics system" consisting of five equipments.

Then the Barry engineering team working with them integrated the factors of weight reduction, structural reliability, heat dissipation, space saving, and vibration and shock protection in a pressure-sealed, plenum-chambered shelf.

All the way, success of this approach demanded the closest kind of engineering liaison, consulting and reporting — from feasibility study through design, redesign, prototype construction, and production.

This TEAM* approach makes the most of the combined experience of your engineers and ours, for an economical design solution. Barry's engineering team handles any phases of the work: feasibility study, design, development, testing, project engineering — and reporting to your engineers. The result; control of vibration and shock *thru design*.

We invite your inquiry on Barry TEAM* capabilities. You can gain most from consulting us when your project is in its earliest stages — write or phone, or call in your local Barry representative.

A report on plenum-shelf design is available in limited quantities. Reprints of the technical articles written by Barry engineers are free on request. The textbook shown is available at technical bookstores.

WESTERN DIVISION • BURBANK CALIFORNIA

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• *Sales representatives in all principal cities* •

Circle 417 on Page 19

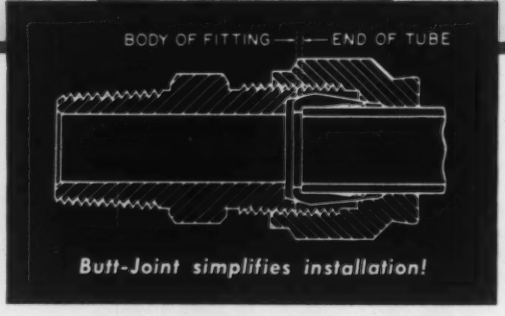
IMPERIAL HI-SEAL BUTT-JOINT FITTINGS

now available in brass, steel and stainless steel

- No flaring or threading
- Withstands higher pressures
- No need to spring tubing
- Permits closer tube bends
- Fast, foolproof assembly
- Meets J.I.C. and A.S.M.E. standards . . . Listed by UL

Tremendous popularity of steel and stainless steel Hi-Seal fittings has led many users to request Hi-Seal fittings in brass. You wanted them—Imperial made them — new brass Hi-Seal fittings . . . plus steel and stainless steel fittings so you can profit from famous Hi-Seal advantages . . . like butt-joint, close bends, quick assembly in the metal best suited to each application.

Tube doesn't enter the body of the fitting. It bottoms on shoulder of the sleeve. Camming action of the nut causes sleeve to form a collet-type triple-seal grip on the tubing.



Final circumferential seal is made by tapered edge of sleeve. No tube torqueing when making a joint. Can be disconnected and reconnected as often as desired.

Write for Bulletin 3061 and complete facts.

See Your Imperial Distributor

IMPERIAL THE IMPERIAL BRASS MFG. CO.

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IMPERIAL—offers industry's most complete line of fittings and tools for steel, stainless steel, copper, aluminum and plastic tubing.

FLARELESS TYPE FITTINGS

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Brass
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Stainless Steel

HI-DUTY
Brass
Aluminum

FLEX
Brass

POLY-FLO
Brass

NYLO-SEAL
Nylon

ERMETO
Steel

COMPRESSION
Brass

FLARED TYPE FITTINGS

37° FLARE
Brass
Steel
Stainless Steel

45° HEAVY DUTY FLARE
Brass

45° FLARE AND INVERTED FLARE
Brass

BRASS PIPE FITTINGS

PRESSURE HOSE AND REUSABLE COUPLINGS

Rubber Covered, Rayon Braid Hose — for low pressures.

Cotton Covered, Single Wire Braid Hose — for medium pressures.

Non-Skive Rubber Covered, Single Wire Braid Hose — for medium pressures.

Rubber Covered, Single Wire Braid Hose — for medium pressures.

Rubber Covered, Double Wire Braid Hose — for high pressures.

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Needle Type
Toggle Type
Diaphragm Type
Plug Type
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TUBE WORKING TOOLS

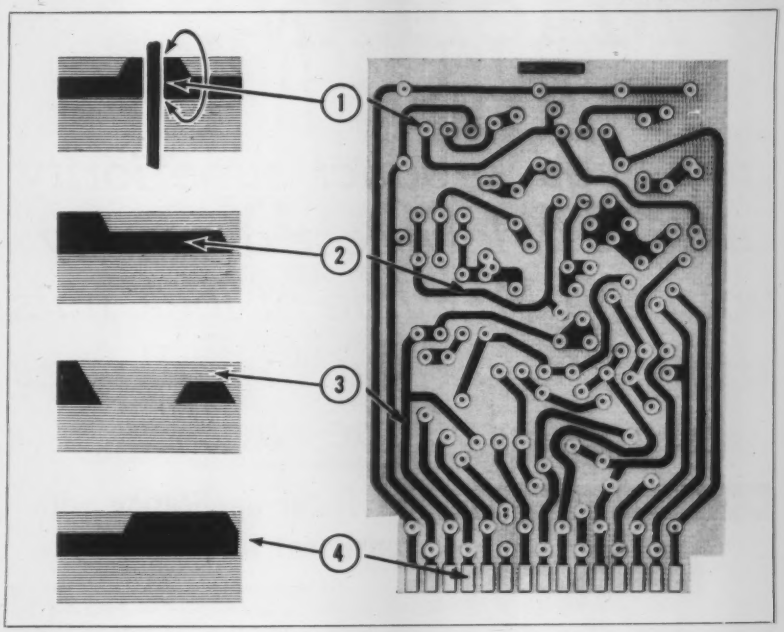
CUTTERS
Tube Cutters
Sawing Vises

FLARING TOOLS
45° Flares
37° Flares
Double Flares

TUBE BENDERS
Lever Type
Gear Type
Spring Type

Reamers
Swaging Tools
Test Plugs and Caps
Refacing Tools

Emblem of Quality I



Rugged Wiring

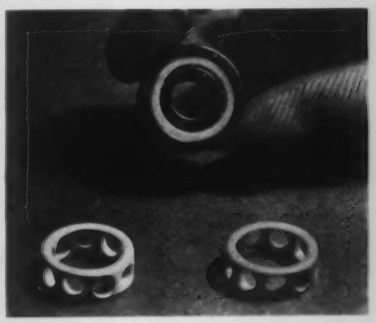
Imbedded circuitry is said to offer reliability beyond any existing industrial or military specification. In process developed by Beck's Inc., St. Paul, Minn., conductors are imbedded in the base material and protected by an insulating cover. Terminals (1) of extra-thick copper give more soldering area. Conductors (2) terminals, and contacts are one solid piece, firmly locked in place. Insulating cover (3) 0.003 in. thick provides 1000 v per 0.001 in. dielectric strength. Contacts (4) can be plated if necessary.

at a recent psychology colloquium:

- Man can do a good job of monitoring machines, provided he is given the information needed for decision-making.
- Man is also very good at making "iterative decisions," each decision leading to a more specific choice, such as in the game of "twenty questions."
- One of man's most serious limitations is his "immediate memory load," or the amount of detailed information he can carry around in his head.

Dr. Fitts has spent the past five years running groups of pilots and air-traffic controllers through air-traffic control simulation. His research, financed by the Air Force, will result in major changes in air-traffic control over the next 5 to 10 years.

Where machines would have to work furiously at decision-making, the psychologist notes, human observers know how to avoid excess work, unnecessary commands, and achieve the same end with a fewer number of moves. Their ability to handle emergencies, he points out, adds a large safety factor to systems.



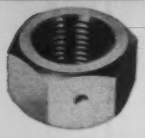
Nylon Stores Oil

Sintered nylon retainer, oil impregnated, is the secret of this bearing's ability to operate for at least 5000 hours under severe preload and speed conditions. Nylon retainers, called Nysorb, hold up to 25 per cent of their own weight of oil even under centrifugal accelerations up to 800 g's. They absorb 10 to 20 times as much oil as conventional phenolic retainers. A typical use is in gyro bearings for inertial-guidance systems where the shifting of even small masses of oil causes navigational errors. Bearings are made by the Barden Corp., Danbury, Conn.

MAC LEAN-FOGG

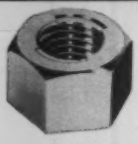
gives you product superiority and fast, low-cost assembly with the M·F line of lock nuts and standard nuts in all sizes "off the shelf"

M·F TWO-WAY LOCK NUT — **for faster application with consistent torque**



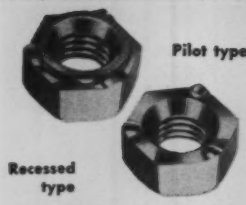
This all-metal, double chamfered, re-usable lock nut can be applied to bolt threads from either end. The center locking principle permits bolt end to be flush with top of nut.

M·F UNI-TORQUE LOCK NUT — **for high torque consistency in full and jam thickness**



This *consistent-torque* lock nut will withstand terrific vibration and shock loading; retains its locking ability for as many as 10 RE-applications.

M·F PROJECTION WELD NUT — **for low-cost assembly**



Solve production delays, cut manufacturing costs—fuse nut to the product in exact location. Engineered for assembly simplification. The welding of nuts to sub-assemblies permits the use of screws or bolts in the main assembly without the need for holding nuts from turning, cutting time and labor.

Both types available with the patented M·F *Two-Way* locking feature. Each type has three welding projections, eliminating rock and guaranteeing a uniform weld.

M·F SPIN LOCK NUT — **the nut with the built-in lockwasher**

This free-spinning one-piece lock nut eliminates the need for supplemental locking devices such as lockwashers. Cuts purchasing and inventory costs.

for you

for the asking

The M·F Products Catalog—valuable data on torque, bolt tension and dimensions as well as on other available products.

MAC LEAN-FOGG Lock Nut Company

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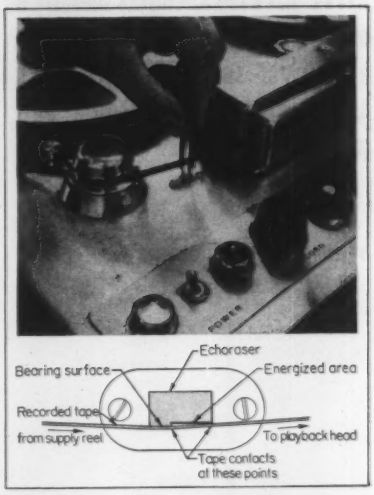


Echo Eraser for Magnetic Tape

Print-through background noise can be removed from otherwise valuable magnetic tapes through the use of a simple device needing no power to operate. Called Echoraser, it consists of an upright chromium-plated brass bar with a small energized area. This area has a magnetic coating which creates the erasing field. Up to 18 db of background noise can be removed—enough to bring 3-year old recordings back to like-new condition. The unit operates by erasing "print through" on the back of magnetic tape without destroying the signal on the face. Echoraser is made by Audio Devices Inc., New York.

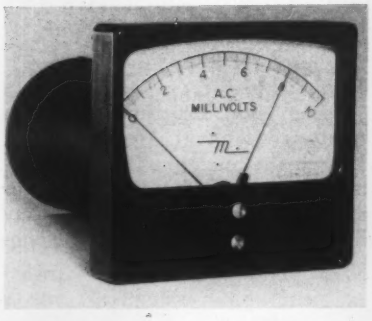
Photo Scientists Confer On New Developments

ROCHESTER, N. Y.—Details of the latest developments in photographic science were reported at the recent second annual conference of the Society of Photographic Scientists & Engineers. Among the advances were:

- A huge 7-ton recording telescope for tracking high-speed missiles, described by George A. Economou of Perkin-Elmer Corp. Designated the ROTI MK LI, the 500-in. focal length instrument is now in use at three points on the Atlantic Missile Range. Economou said the telescope uses 70-mm film to record the missile image.
- A system for rapid processing of radar recording film, described by J. B. Taylor of Ansco. Taylor told of matching film sensitivities to light emitted from cathode-ray

tubes in research which lead to a special film. Called Ansco Hyscan, the film has sensitivity to the color of light emitted by cathode-ray tube phosphors. Its special characteristics allow its complete development within 5 sec. without stop bath or fix, he said. Heated high-energy developer provides the developing speed.

• For satellite surveillance and detection, a new synchronized camera records the exposure streak of a faint satellite image, reported by J. T. Leininger of the U. S. Naval Ordnance Test Station, China Lake, California. If the film is moving at the exact rate of satellite image travel, the satellite will appear ideally as a dot on the film. Long exposures made possible capture images too faint to be recorded by other cameras.



Miniature Electronic Voltmeter

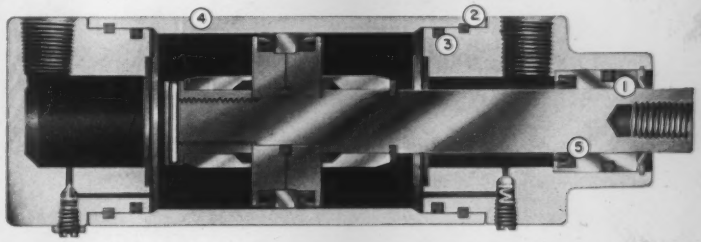
Vacuum-tube voltmeter small enough to mount on a control panel, combines the functions of electronic voltmeter and circuit controller. Easily positioned stationary contacts mate with a moving contact on the meter pointer to actuate the control circuit at either high or low limits. Meter was developed by Metronix, Inc., Chesterland, O.

U. S. Offers U.S.S.R. Abstracts

Russian and other foreign technical information wil be made available to American industry by the Foreign Technical Information Center, which has begun operation in the Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

Translations will be listed in a

CARTER
CYLINDERS
AIR OR HYDRAULIC



Designers get 3 Important Benefits by Standardizing on the Superior CARTER Design

THE CARTER DESIGN

1—Full 1 to 1 Meehanite cartridge rod bearing.

2—Key type stainless steel locking ring. Allows 360° rotation of ports.

3—Leakproof "O" Ring seal between head and wall.

4—Precision honed heavy wall tubing—6 to 1 safety factor.

5—Spring loaded "V" packing on rod end gland.

IMMEDIATE DELIVERY FROM STOCK

SAVINGS IN SPACE—40% savings in space. Helps build more compact, functional equipment. Where other cylinders won't fit, Carter will!

IMPROVES PRODUCT QUALITY Carter cylinders are stronger, more efficient. Completely leakproof! Better performance, longer life. The finest cylinder for your product.

ENGINEERING SERVICE and sales in 40 locations throughout the United States, Canada, Mexico, and Europe.

FREE DESIGNERS' FILE

Details on air, hydraulic, valves, built-in-valve types. All necessary data for designers.

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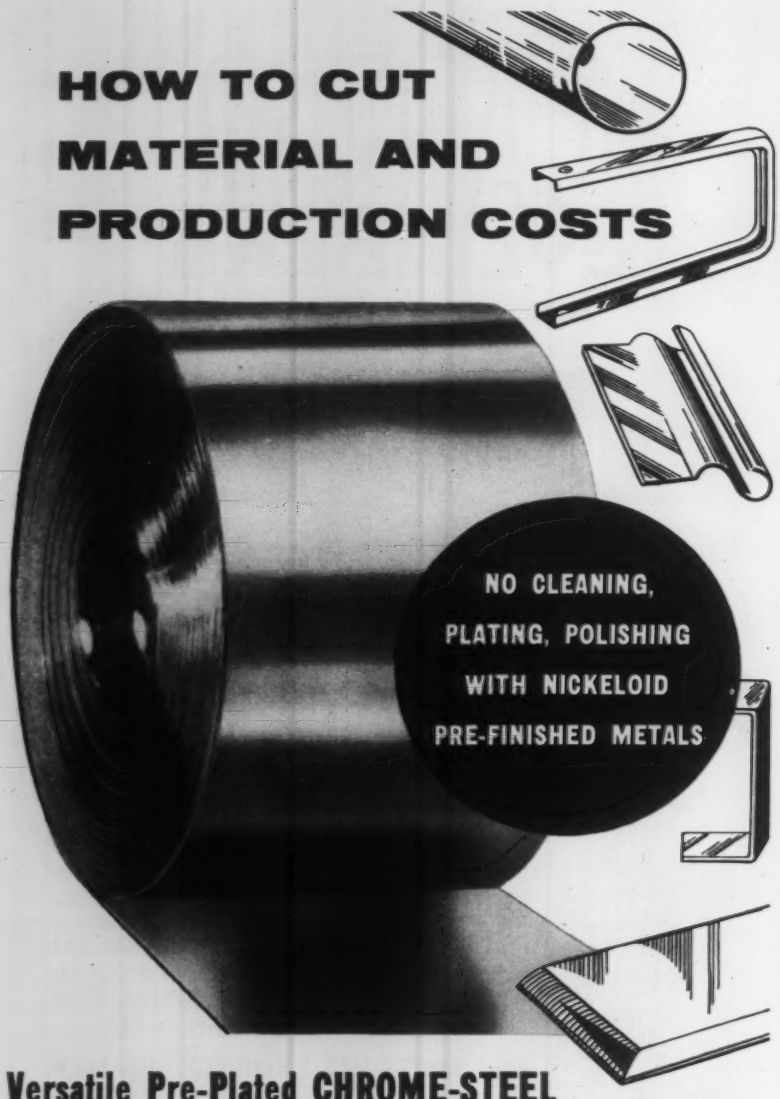
AIR CYLINDERS • AIR VALVES • HYDRAULIC CYLINDERS
ROTARY ACTUATORS • SPECIAL CONTROLS

Circle 421 on Page 19

HOW TO CUT MATERIAL AND PRODUCTION COSTS



Versatile Pre-Plated CHROME-STEEL and NICKEL-STEEL Now Available in Three Grades

Cut costs! — Reduce production steps! The *need* was never greater: the *method* never surer than with Nickeloid chrome-steel and nickel-steel . . . now available in C-grade, *a new low-cost utility grade* for applications that don't require the quality of our A and B grades. These cost-cutting design materials are *pre-finished* — eliminate extra handling, cleaning, racking and polishing costs, plus actual plating costs. So versatile — adaptable to standard production methods, too! Their beautiful durable finishes can add so much in sales and utility value to your products at very low cost. Cut costs, reduce production steps with Nickeloid chrome-steel or nickel-steel — big 24" wide coils, sheets, strips: bright and satin finishes. Now save even more with new low-cost C-grade!

NICKELOID METALS SINCE 1898 N·M

Write For More Information

AMERICAN NICKELOID COMPANY

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MILLS — Peru, Illinois and Walnutport, Pennsylvania Sales Offices Throughout the U.S.A.

special abstract journal expected to go into publication very soon. Initial services now under way include publication of abstracts of all articles appearing in 141 Soviet technical periodicals, translations of important sections of *Referativnyy Zhurnal* (the Russians' abstract journal), and a semimonthly review of various areas of Soviet science compiled by the Central Intelligence Agency.

Meetings

AND EXPOSITIONS

Nov. 10-14—

National Electrical Manufacturers Association. Annual Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Further information is available from NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 12-14—

Society for Experimental Stress Analysis. Annual Meeting to be held at the Sheraton-Ten Eyck Hotel, Albany, N. Y. Further information is available from society headquarters, P. O. Box 168, Cambridge 39, Mass.

Nov. 12-15—

Society of Naval Architects and Marine Engineers. Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Further information can be obtained from society headquarters, 74 Trinity Place, New York 6, N. Y.

Nov. 17-18—

Conference on Magnetism and Magnetic Materials to be held at the Sheraton Hotel, Philadelphia. Conference is sponsored by the American Institute of Electrical Engineers, in co-operation with the American Physical Society, the Institute of Radio Engineers, the Metallurgical Society of AIME, and the Office of Naval Research. Further information can be obtained from Mr. C. J. Kriessman, Remington Rand Univac, 1900 W. Allegheny Ave., Philadelphia, Pa.

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Nov. 17-21—

Society of the Plastics Industry Inc. National Plastics Exposition and Annual Conference to be held at the International Amphitheatre, Chicago. Further information can be obtained from society headquarters, 250 Park Ave., New York 17, N. Y.

Nov. 18-20—

American Standards Association. Ninth National Conference on Standards to be held at the Hotel Roosevelt. Further information can be obtained from ASA headquarters, 70 E. 45th St., New York 17, N. Y.

Nov. 30-Dec. 5—

American Society of Mechanical Engineers. Annual Meeting to be held at the Statler Hilton and Sheraton-McAlpin Hotels, New York. Additional information can be obtained from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Dec. 1-3—

American Society of Refrigerating Engineers. Semiannual Meeting to be held at the Roosevelt Hotel, New Orleans. Additional information is available from society headquarters, 234 Fifth Ave., New York 1, N. Y.

Dec. 1-5—

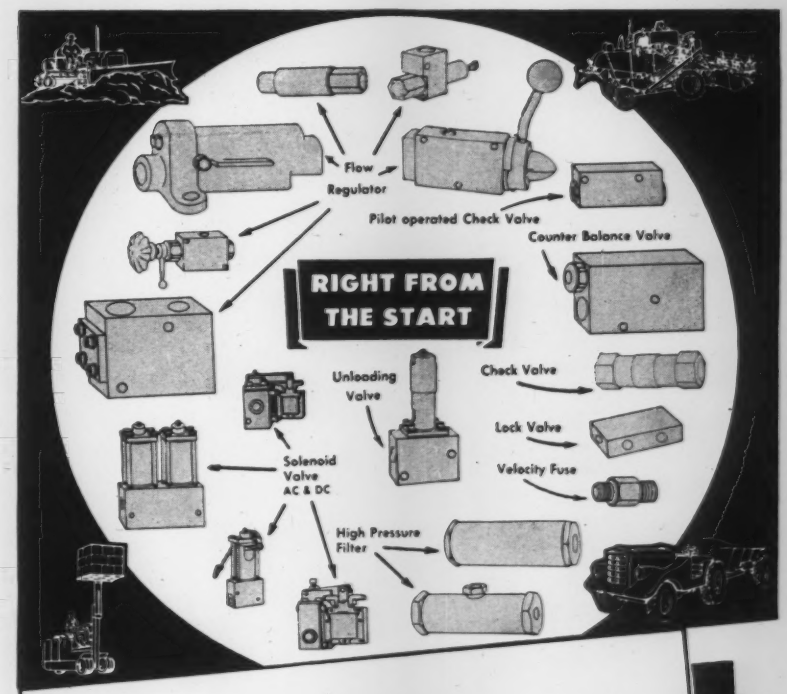
23rd National Exposition of Power and Mechanical Engineering to be held at the Coliseum, New York. Exposition is under the auspices of ASME. Further information is available from International Exposition Co., 480 Lexington Ave., New York 17, N. Y.

Dec. 2-4—

Electronic Industries Association. Conference on Reliable Electrical Connections to be held at the Statler Hilton Hotel, Dallas. Further information is available from Mr. R. George Roesch, 1068 S. Clinton St., Syracuse 4, N. Y.

Dec. 8-10—

American Nuclear Society. Annual Meeting to be held at the Sheraton-Cadillac Hotel, Detroit. Further information can be obtained from the society's Detroit headquarters, 2000 Second Ave., Detroit 26, Mich.



CONTROLLING FLOW IS OUR BUSINESS

All of the above valves have been used in various types of applications, including Material Handling, Road Building, Machine Tools, Farm Equipment and Earthmoving.

Waterman Engineering Company has also supplied valves to the Military for Ground Support Equipment and Missile Launchers.

We invite you to send us your applications and take advantage of our experience to help analyze your problems.

Bulletins of any of these products sent on request.

Also suppliers of AN and MS qualified Flow Rate and Volume Controls to the Aircraft Industry.

WATERMAN ENGINEERING COMPANY
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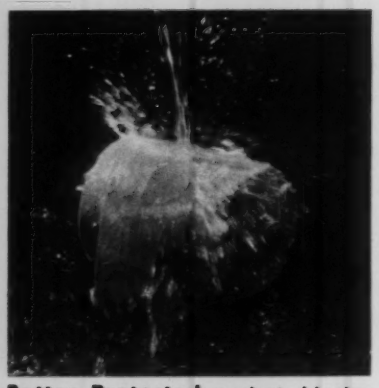
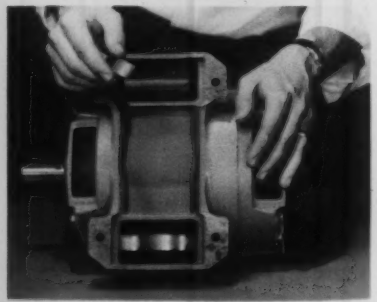
Circle 423 on Page 19 Circle 424 on Page 19→

Get faster assembly–more dependable

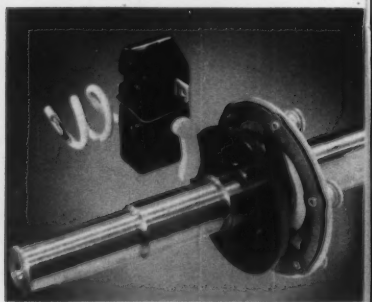


Better Protected against dripping or splashing liquids, this G-E motor is suitable for many jobs where an ordinary dripproof motor cannot be applied.



Base-mounted Capacitors eliminate bulky capacitor "top hat," are safe from physical damage. Easy-to-remove spring clips hold capacitors in place.

Perma-Numbered Leads are always easy to identify. Non-wicking neoprene insulation prevents moisture from running up leads into vital parts.



Totally-enclosed Transfer Switch assures positive contact and long life—over 1,000,000 consecutive operations on test.

operation for your products . . .

WITH GENERAL ELECTRIC TRI 55 CLAD SINGLE-PHASE MOTORS

HERE'S WHY:

Perma-numbered leads in the G-E Tri/Clad '55' motors make connection easier because they are easy to identify. Threaded conduit entrance eliminates need for internal lock nut . . . faster installation results. And rigid cast-iron frame and endshields prevent motors from being twisted out of line during assembly operations—make machine operation more dependable.

THE SMALL SIZE AND LIGHT WEIGHT of Tri/Clad '55' standard motors facilitates installation on your products; helps reduce mounting and shipping costs *without* sacrificing full-power performance. Also, G.E.'s dripproof design allows these single-phase motors to be used for many applications which normally require splashproof type motors . . . you save money.

FOR LONGER MOTOR LIFE, G-E Tri/Clad '55' motors feature Mylar* polyester film insulation, Formex† magnet wire, water-resistant stator coating, and better physical protection. Longer motor life, of course, results in longer life and increased dependability for your products.

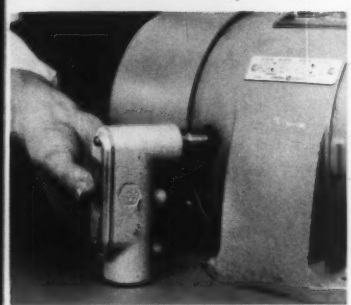
COMPARE G-E Tri/Clad '55' motors with other makes of motors. Remember: (1) General Electric offers you a complete line of single-phase motors to choose from . . . dripproof or enclosed, vertical or horizontal, C-face or D-flange, all of which meet NEMA standards. (2) You'll also be pleased with the *exceptionally* fast delivery you can get and with G.E.'s small motor service station plan . . . a real plus in cementing customer relations.

CONTACT your local G-E Apparatus Sales Office now for personal proof of how these G-E motors can help cut your costs, reduce assembly time, and give longer-life operation. And ask for your free copy of illustrated bulletin GEA-6240, or write Section 840-18, General Electric Company, Schenectady 5, New York.

*Registered Trade-mark of DuPont Co.

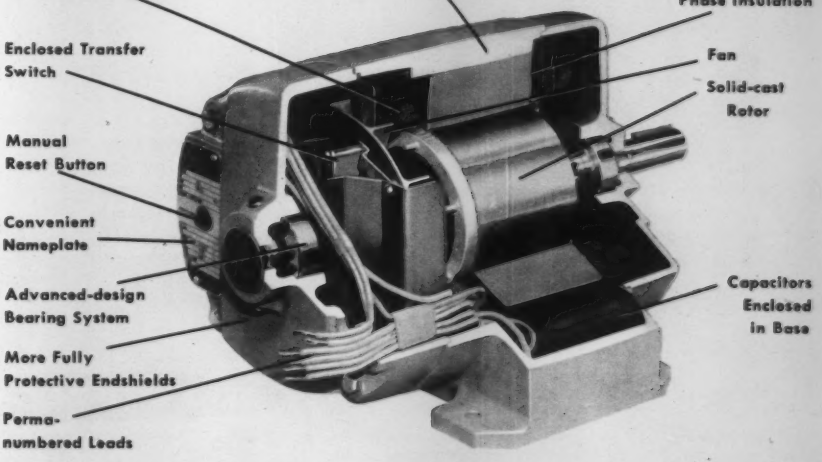
†Registered Trade-mark of General Electric Co.

GENERAL ELECTRIC



Threaded Conduit Entrance permits quick, easy installation; provides tighter, dust-proof seal for conduit.

SINGLE-PHASE TRI 55 CLAD MOTORS OFFER THESE TIME AND MONEY SAVING FEATURES



Standard single-phase Tri/Clad '55' motor

FAST, HAMMER-DRIVEN RIVET ECONOMICAL FOR BLIND AND OPEN APPLICATIONS

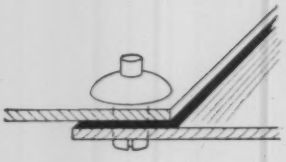


Fig. 1 Inserted in hole, Southco Rivets are quickly set by driving pin with hammer. No special tools are required. Bucking is not necessary.

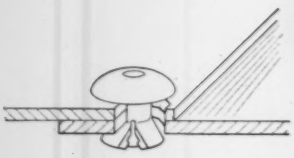


Fig. 2 Expanded prongs force sheets or parts together, hold them tightly in compression. No metal is removed, no grinding or finishing is required.

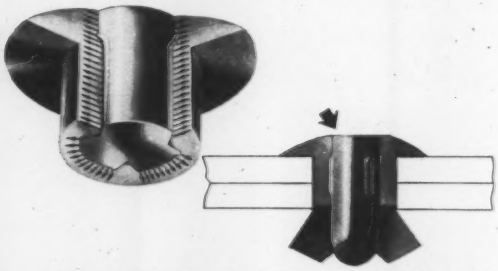


Fig. 3 Pin is locked securely into rivet by displaced metal filling unique grooves. Compression forces are utilized for greater strength.

Fig. 4 Ideally suited for "blind" applications, Southco Rivets are worked by one man from one side only and require minimum space inside closed area. They eliminate costly bucking arrangement or time-consuming finishing. Supplied as a unit, they require no job time for assembly or fitting.

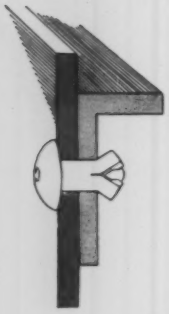


Fig. 5 Access or open fastening utilizes the simplicity, speed and vibration-resistance of Southco Rivets.

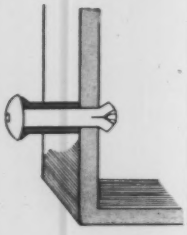


Fig. 6 Ferrules are used as spacers for numerous applications. Here the Southco Rivet forms a drawer pull in conjunction with a flanged tube.

Fig. 7 Increased head size distributes holding pressure over larger area, permits higher loading on wood, plastics and similar materials.

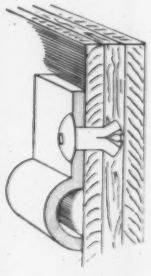


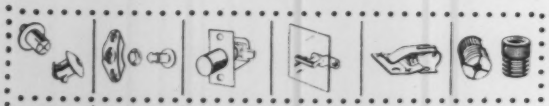
Fig. 8 A blind head can be formed inside the wood. This application is particularly useful when it is desirable to have one surface of the wood unmarred.

FREE

RIVET FOLDER

Send for your free copy of "Southco Drive Rivets" Folder. Gives complete information on the application, installation, and specifications of aluminum and steel Drive Rivets.

Write on your letterhead to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pennsylvania.



SOUTHCO FASTENERS

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LION

Circle 425 on Page 19

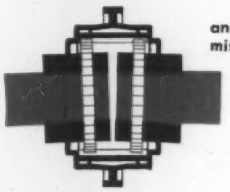
LINK-BELT motor couplings...

geared for top economy and long wear

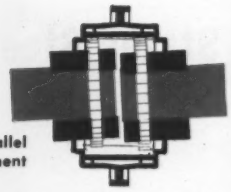
NEW!

Durable, lightweight design consists of two externally geared steel hubs, which engage flexibly with an internally geared steel sleeve — all enclosed in a protective two-piece metal cover. Synthetic rubber O-rings and felt hub seals effectively retain lubricant and exclude outside contamination.

Misalignment protection



angular misalignment



parallel misalignment

Link-Belt Motor Couplings accommodate free angular and parallel misalignment.

Now you can afford flexible geared couplings on small electric motor applications. New Link-Belt MC motor couplings are *geared* couplings—the established standard of performance throughout industry. And at a new *low price*, these couplings are no longer too expensive for smaller motor applications.

High capacity and durability are embodied in the all-metal design. Assembly or disassembly is quick and easy . . . fast-acting quarter-turn spiral cam fasteners are a permanent part of the cover. No loose nuts or bolts.

Equipment manufacturers will discover special economies in Link-Belt MC couplings—they are excellent for such equipment as speed reducers, pumps and generators. Available "off-the-shell" for shafts up to 1⅞".
Contact your nearby Link-Belt office.

Write for Folder 2875—Gives detailed information and specifications on the new Link-Belt MC motor coupling.

14,950

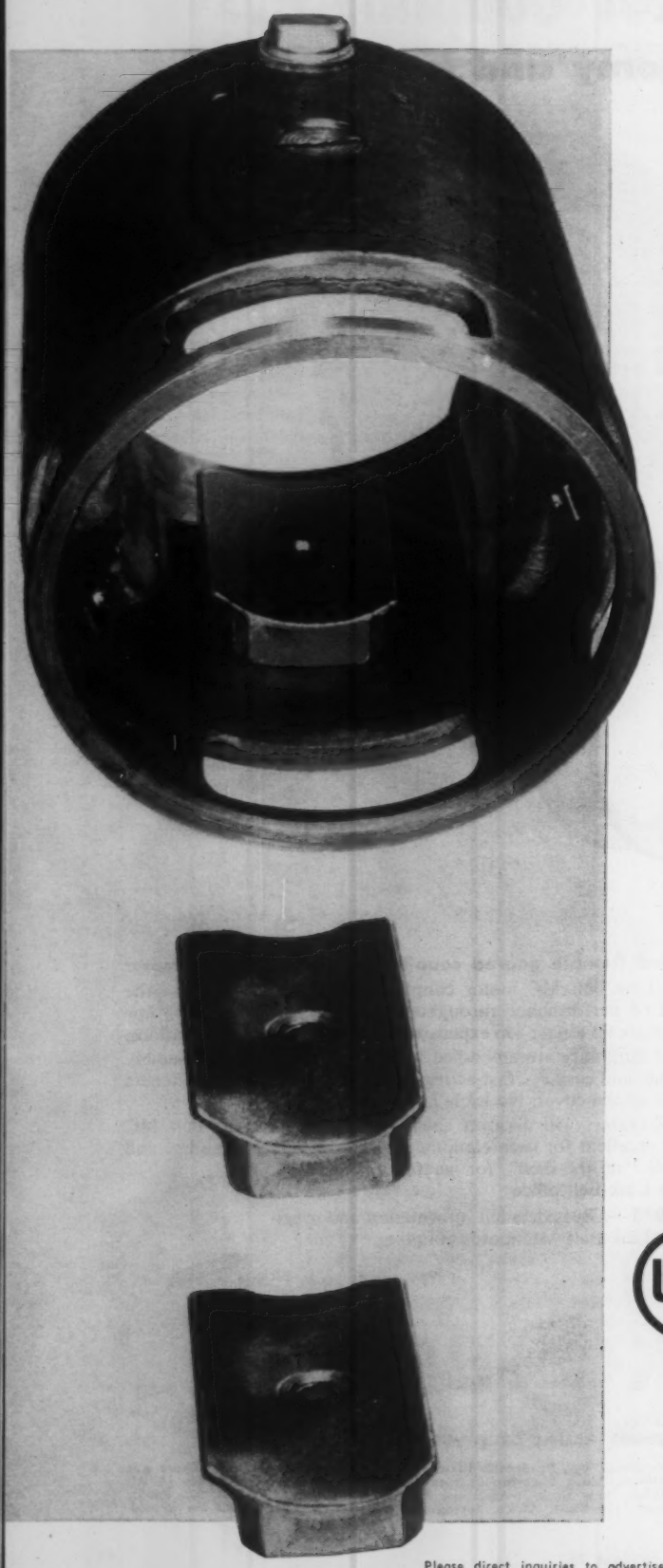
LINK-BELT

GEARED FLEXIBLE COUPLINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

Circle 426 on Page 19

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS



Auto starter pole shoes by the thousands—

made from steel already rolled to shape!

An automobile parts manufacturer produces thousands of automobile starter motors daily. Each one takes four pole shoes. To machine these parts from rectangular bars or to use built-up laminations was too slow and too costly.

They solved the problem by making the pole shoe from USS Special Section Rolled Steel Bars. The cross section of the bar is rolled so close to that of the pole shoe that no machining is required. They merely shear the shoe to length, punch the mounting hole, clean and tumble, coin to obtain precise curvature, and tap the hole.

These operations are set up on a mass-production basis and pole shoes come tumbling out at a rate of 11,000 per day, or more. There's very little scrap and unit costs have been reduced to a minimum.

Why not find out what USS Special Sections can do for you? For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS is a registered trademark

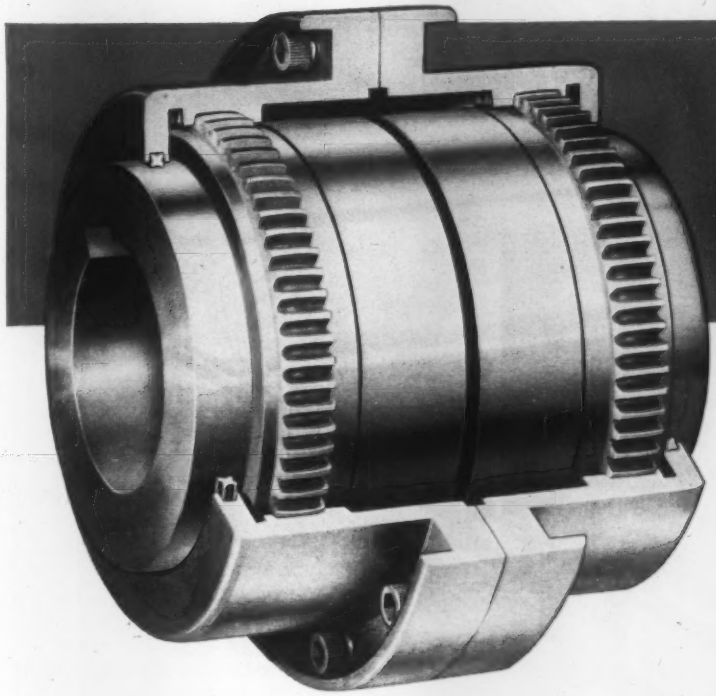
A better product at lower cost when pole shoes are manufactured from USS Special Section Bars.

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company

United States Steel

Why LINK-BELT geared flexible couplings can

transmit more hp per coupling dollar



Size for size, they accommodate larger shafts . . . transmit more power than other comparable couplings

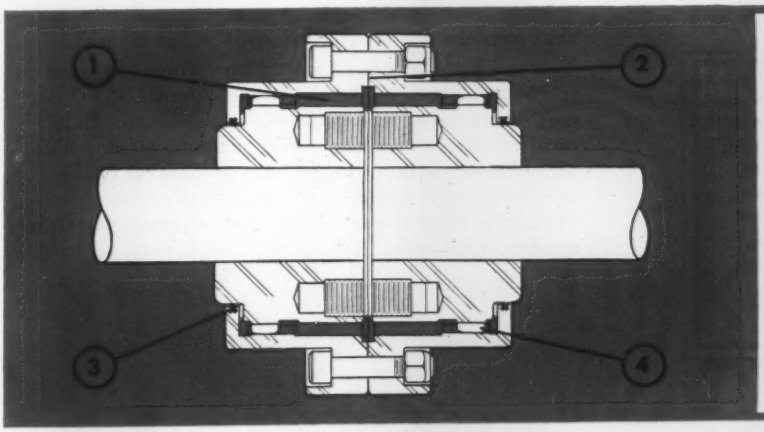
LINK-BELT geared flexible couplings offer an ideal combination of compactness, performance and low cost. They're designed for high load capacity, yet cost less because they are smaller.

Hardened steel socket head flange bolts —ground for close fit—are the key to compactness. They permit a smaller flange. Thus, more of the coupling diameter is devoted to the gear and a larger hub which can be bored to accommodate larger shafts.

In a great variety of coupling applications—including those where shock, vibration, reversing loads and misalignment are encountered—these couplings can be used effectively to assure long life and minimum maintenance. Popular sizes are available with finished bores, packaged and ready for installation. For complete details, contact your nearby Link-Belt office. Or write for your copy of Folder 2775.

LINK-BELT

GEARED FLEXIBLE COUPLINGS



2-piece housing design assures efficient sealing and lubrication

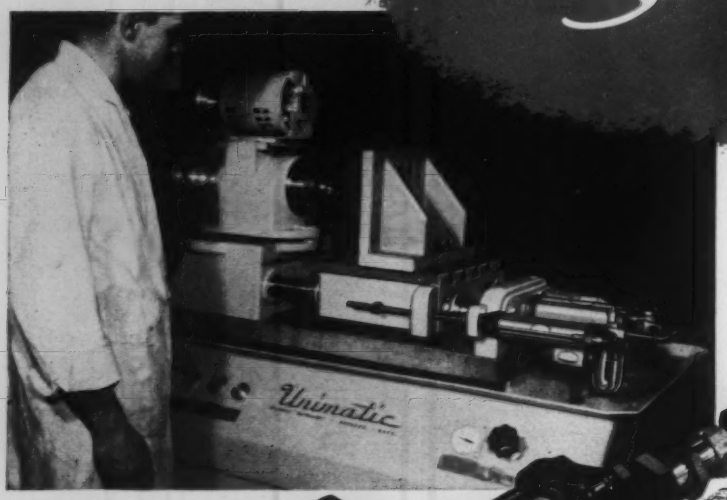
1. In operation, the lubricant centrifuges to the working gear surfaces at the perimeter of inside cavity.
2. Fiber gasket fits tightly between flanges. Lubricant can't escape.
3. Hub seal is smaller in diameter than gear teeth and running level of lubricant. No leakage is possible—dirt and water stay out.
4. Mating gear teeth are constantly lubricated, preventing wear and providing long, trouble-free operation.

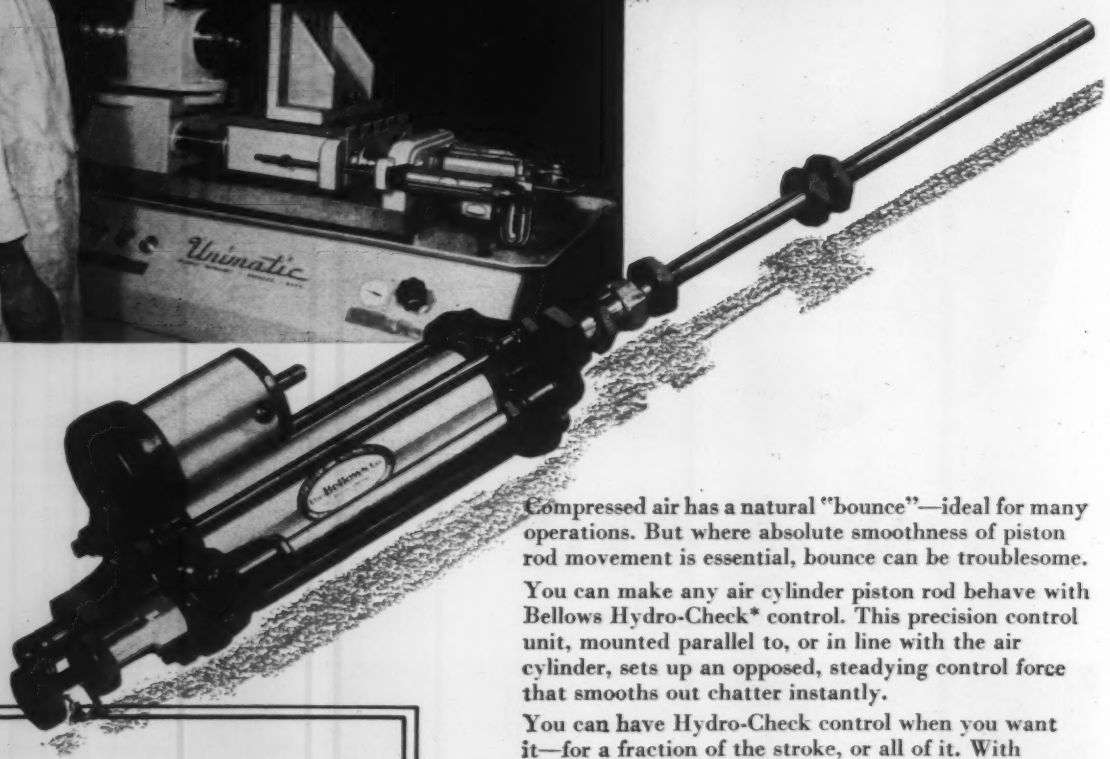
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,484-A

Circle 428 on Page 19

how to give any air cylinder...

Hydraulic Smoothness





Compressed air has a natural "bounce"—ideal for many operations. But where absolute smoothness of piston rod movement is essential, bounce can be troublesome.

You can make any air cylinder piston rod behave with Bellows Hydro-Check* control. This precision control unit, mounted parallel to, or in line with the air cylinder, sets up an opposed, steadying control force that smooths out chatter instantly.

You can have Hydro-Check control when you want it—for a fraction of the stroke, or all of it. With certain models of Hydro-Checks you can have "Skip"—or intermittent checking action; or you can stop an air cylinder piston at any point in its travel for a predetermined time and then resume traverse. Hydraulic control can be on either advance or retract strokes or on both.

*T.M.Reg.

If you use air cylinders in precision operations, you'll want to know more about Bellows Hydro-Checks—precision hydraulic control for air cylinder power. Write for Bulletin HC-602 Address: The Bellows Co. Dept. MD1058 Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd. 14 Advance Rd., Toronto, Ont.

The Bellows Co.

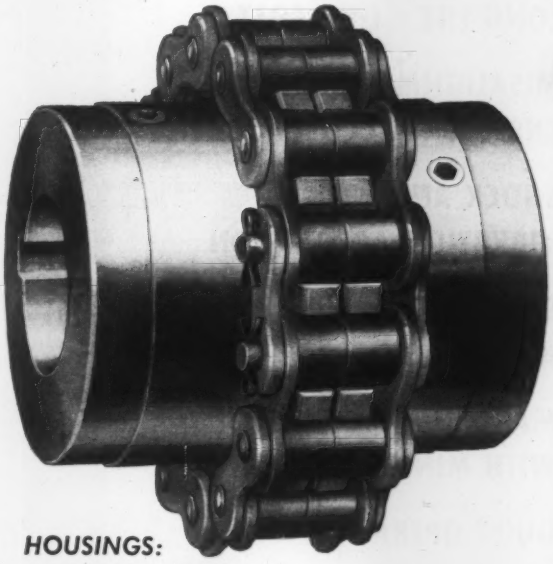
DIVISION INTERNATIONAL BASIC ECONOMY CORPORATION

AKRON 9, OHIO

1223-A-1

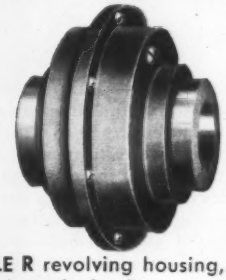
Circle 429 on Page 19

Why LINK-BELT "RC" spells the **Right Coupling** ***when you want...***



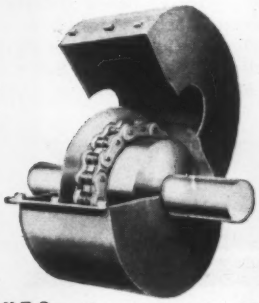
1. Simplicity
2. Low cost
3. Dependability

HOUSINGS:



STYLE R revolving housing, spun metal, vertical split.

STYLE P revolving housing, plastic, horizontal split.



STYLE S stationary housing, fabricated steel.

Exclusive divided roller design gives you all three

Here's a reliable shaft coupling that meets every requirement for economical power transmission. Because the divided rollers make independent contact with each coupling half, Link-Belt "RC" flexible couplings give you *equalized load . . . proper balance at high speeds . . . effective compensation for shaft misalignment.*

Durability is another feature of these *all-steel* couplings. All parts are precision-made and hardened for reliable long life.

Low initial cost . . . easy installation and maintenance . . . dependable performance—they're all yours with Link-Belt "RC" flexible couplings. And they're available in a wide range of sizes for shafts up to 12 inches.

COMPLETE DETAILS on Link-Belt "RC" flexible couplings are contained in Folder 2363. Contact your local Link-Belt office for a copy.

LINK-BELT

"RC" FLEXIBLE COUPLINGS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,488

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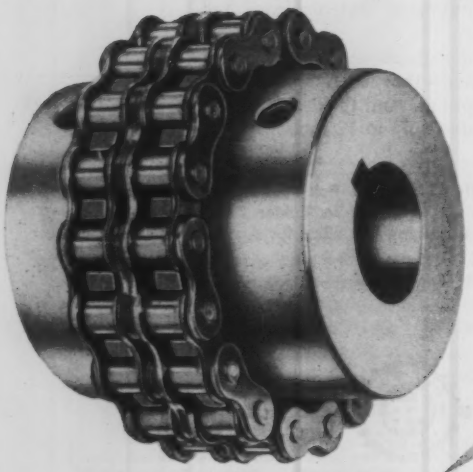
You get all these advantages in REX® Flexible Couplings



LONG LIFE • LOW COST

MISALIGNMENT AND END FLOAT ACCOMMODATION

SHOCK AND VIBRATION ABSORPTION

EASY INSTALLATION AND REMOVAL

MAXIMUM FLEXIBILITY WITH MINIMUM BACKLASH

QUIET OPERATION

Rex Roller Chain Flexible Couplings give you *all* the advantages you want and need in a flexible coupling. In any application up to 670 h.p....shaft sizes ranging from ½ to 5 inches, these all-steel couplings give you positive transmission of power, maintain their full capacity throughout their long service life.

The unique design of Rex Flexible Couplings assures positive protection against unavoidable minor misalignments that occur in even the most careful shaft installation. They're especially advantageous on high-speed shafts because precise balancing eliminates vibration and noise. Their all-steel construction enables them to stand up under any punishment the shaft will take.

Rex Couplings are made up of three simple parts...two sprockets and one double-strand roller chain. Sprocket teeth are made to a special form that enables the coupling to accommodate angular deflection of the shaft and yet hold back-lash to the minimum. Built-in clearances between the chain round parts provide accommodation of parallel misalignments. Clearances between special sprocket teeth and roller link plates, as well as clearances between chain rollers and tooth gap of coupling sprockets, provide accommodation of angular misalignments and end float. Cushioning effect of oil film between working parts effectively dampens vibration and assures quiet operation.

For effective protection...positive power transmission... easy installation and removal...long service life at low cost, specify Rex Roller Chain Flexible Couplings. For all the facts, send for your copy of Bulletin 577. CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis.

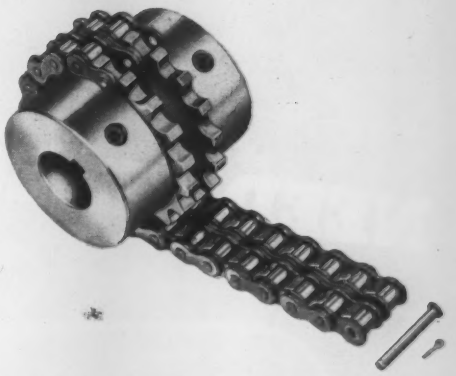
REX®

FLEXIBLE COUPLINGS

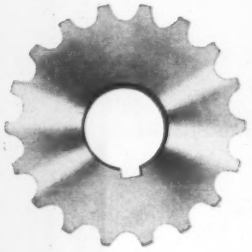
CHAIN Belt Company

SIMPLE, ALL-STEEL CONSTRUCTION

All-steel hardened tooth sprockets and heat-treated steel roller chains provide maximum service life under severe operating conditions. No short-lived materials to cause early failure and excessive maintenance and down time... no leather, fiber, rubber or other quick-wearing materials.



ACCOMMODATES ANGULAR AND PARALLEL MISALIGNMENTS

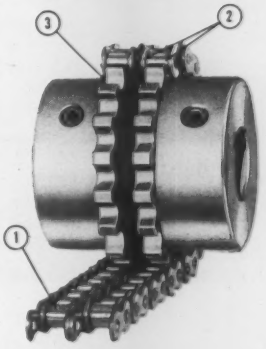


Exclusive tooth form enables Rex Couplings to handle angular and parallel deflection of the shafts and still keep backlash to the minimum. Tooth form also assures extra coupling life since it will accommodate twice the maximum elongation of the chain.

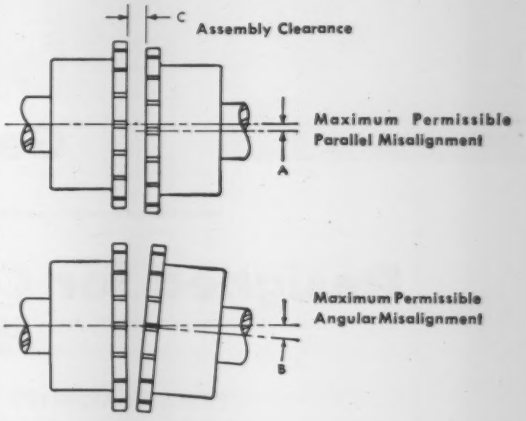
Maximum Permissible Misalignment and Assembly Clearances for Rex Roller Chain Couplings

Coupling No.	*A	*B	C
D35-18	0.008"	2°	¼"
D40-18	0.011"	2°	5/16"
D50-16	0.012"	2°	13/32"
D60-18	0.014"	2°	½"
D60-22	0.014"	2°	½"
D80-14	0.016"	2°	5/8"
D80-18	0.016"	2°	21/32"
D80-22	0.016"	2°	11/16"
D100-20	0.020"	2°	27/32"
D120-18	0.024"	2°	1"
D140-18	0.029"	2°	1 1/32"
D160-16	0.034"	2°	1 9/32"

**Misalignment is not desirable. If it does exist, it must not exceed limits in columns A and B.*

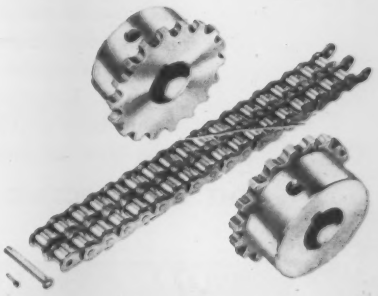


(1) Built-in clearance between chain round parts...(2) between sprocket teeth and chain side plates... (3) between chain rollers and sprocket tooth gap of the coupling halves...provides ability to accommodate angular and parallel misalignment.



EASY TO INSTALL OR REMOVE

Just remove the single connecting pin in the chain strand and you disconnect the coupling halves. No bolts to remove...no complicated parts. When disconnecting a Rex, there is no need to make an axial shift of either shaft. Installation is just as simple. Just wrap the chain around the sprockets and insert the pin.



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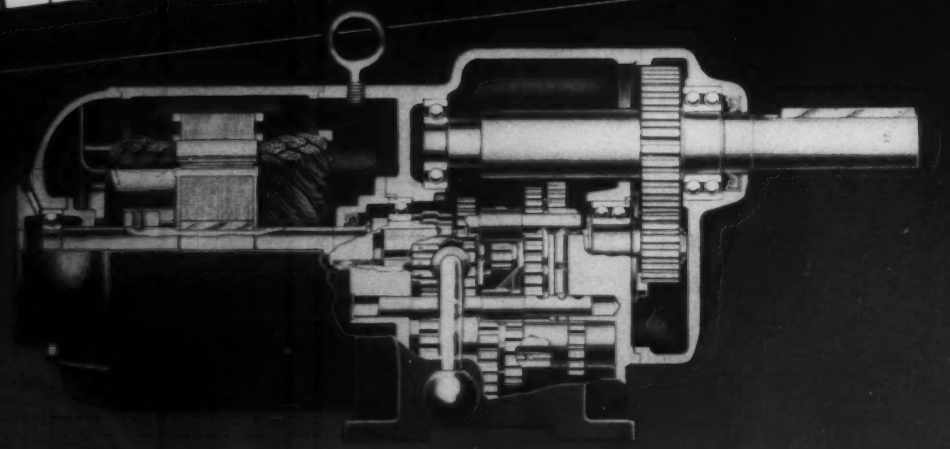
NEED SELECTIVE SPEEDS?



— the ***RIGHT CHOICE***...

LIMA

Gearshift Drives

Designed for *Continuous* HEAVY-DUTY Service

LIMA GEARSHIFT DRIVES provide an individual power source for machine tools and other equipment wherever constant-horsepower and multiple speeds are required. The modern LIMA *Selective Speed* DRIVE is a compact combination of a four-speed sliding gear transmission and a heavy-duty induction motor. For increased production, lower operating costs, minimum maintenance and maximum safety . . . specify Lima Drives. Experienced Factory Representatives are in the field to give your drive problems immediate and *personal* attention. Write today for the New brochure on Lima Gearshift Drives . . . ½ to 15 Horsepower.

THE LIMA ELECTRIC MOTOR CO., INC., 4880 Findlay Road Lima, Ohio

A Division of Consolidated Diesel Electric Corp.

FIRST . . . FOR DRIVES . . . MOTORS . . . SPEED REDUCERS

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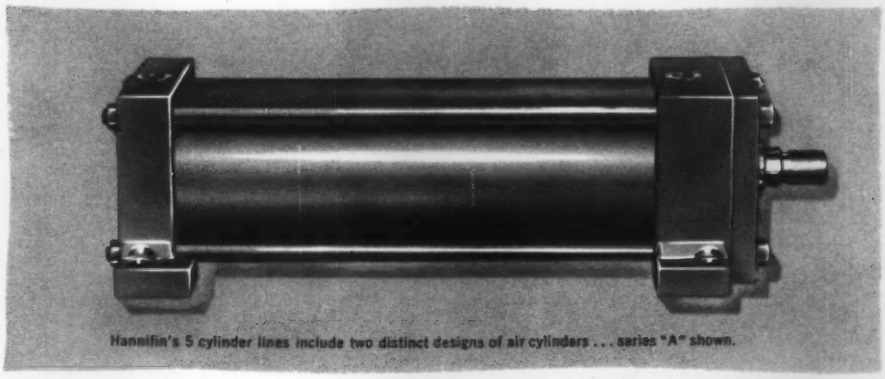
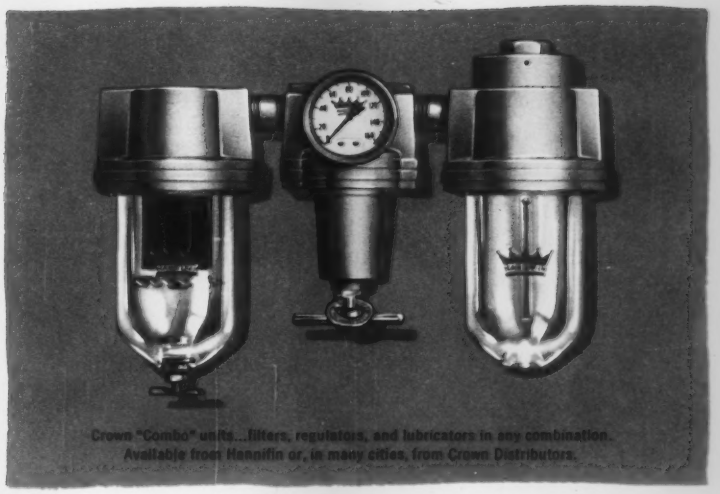
PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS

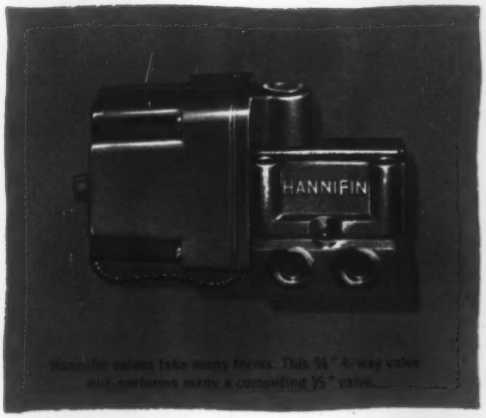


Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



Crown "Combo" units...filters, regulators, and lubricators in any combination. Available from Hannifin or, in many cities, from Crown Distributors.

Only HANNIFIN makes all these AIR POWER COMPONENTS



Hannifin valves take many forms. This ¼" 4-way valve also performs many a compelling ½" valve.

Anywhere you use compressed air to do work, Hannifin can help you. Hannifin cylinders for the "muscles". . . Hannifin air valves for any type of actuation, hand, foot, cam, solenoid, or pressure . . . the Hannifin "Crown" Line of filters, regulators, and lubricators for lasting air power efficiency . . . all are built by Hannifin to just one standard, the best.

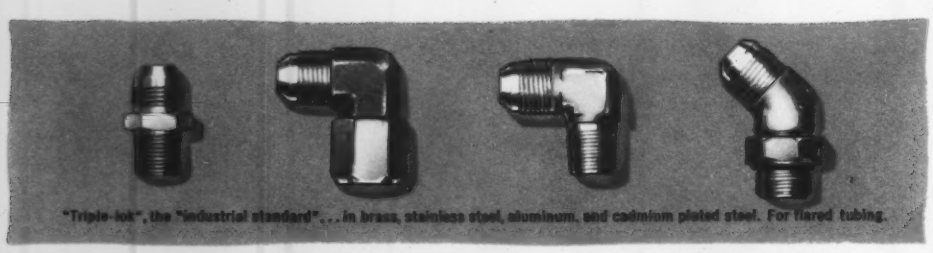
Turn to Hannifin, too, for expert help in applying air power components. A Hannifin field engineer is as close to you as your telephone, wherever you are. Write us for his address—or, he's listed in the alphabetical section of Thomas Register. It's that easy.

HANNIFIN COMPANY

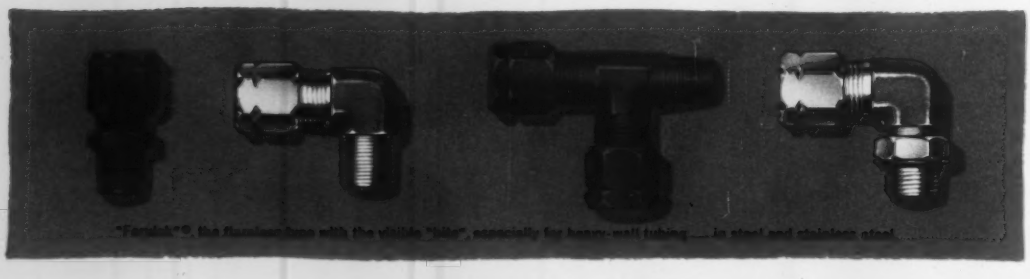
505 South Wolf Road • Des Plaines, Illinois

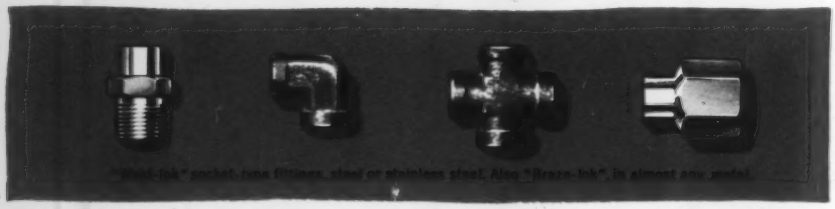
A DIVISION OF PARKER-HANNIFIN CORPORATION

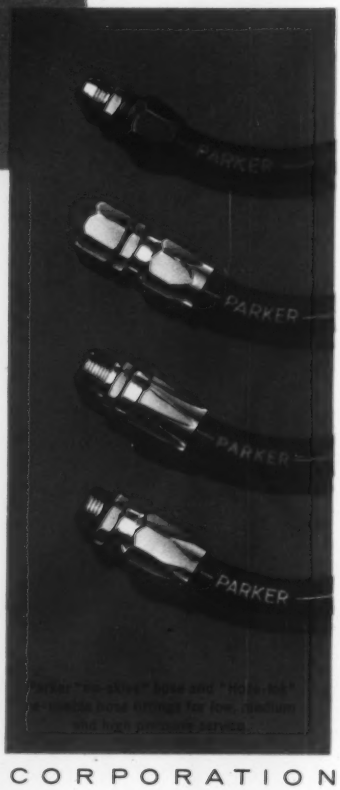
PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS



"Triple-lok", the "industrial standard"... in brass, stainless steel, aluminum, and cadmium plated steel. For flared tubing.







Only from Parker

such a wide range of fittings...so fast

If it's an industrial fitting, whether for tubing or for hose, Parker has it or can make it, in standard sizes in any metal.

Parker "Triple-lok" for flared tubing . . . Parker "Ferulok"® for heavy-wall tubing . . . Parker "Weld-lok" for high-temperature, high pressure lines. ("Braze-lok", our newest line, does not require an open torch, is for medium temperatures.) "Intru-lok", for copper, aluminum or plastic instrumentation lines, requires no flaring. Parker hose and "Hoze-lok" re-usable hose fittings require no skiving of the hose.

There's a Parker distributor near you, write us for his name . . . call him for Parker catalogs.

Parker Fittings and Hose Division
17325 Euclid Avenue • Cleveland 12, Ohio

A DIVISION OF PARKER-HANNIFIN CORPORATION

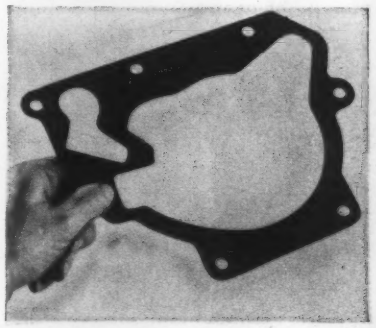
Technical data for gasket design and selection

NUMBER SIX

New asbestos gasket will not crush or extrude under heat and pressure

The combined effects of high flange loads and ambient temperatures in the 300° F. range impose severe demands on gasket materials.

In some applications—as, for example, in modern automotive transmissions—these operating conditions can cause extrusion and crushing of conventional gasket materials.



Effective sealing under such conditions requires a dense material with unusual resistance to crushing at high temperatures. A material that meets these requirements is Accopac AN-890, a new Armstrong asbestos gasket.

Under test loads of 100,000 psi at temperatures of 350° F., AN-890 shows no noticeable extrusion or crushing. Indications are that the excellent torque retention properties of AN-890 would not be impaired even at much higher temperatures.

AN-890 is made by a beater-saturation process pioneered and patented by Armstrong. This method coats the fibers uniformly with a nitrile-type latex rubber binder and links them so tightly that crushing and extrusion are eliminated in normal applications.

With all its advantages, AN-890 costs less than conventional compressed asbestos materials. For more information, send for a copy of bulletin IND-915.

How internal pressure affects the selection of resilient gasket materials

Resilient gasket materials are most widely used where internal pressures are relatively low (e.g., up to 100 psi).

Because of pressure surges or intentional design, resilient materials sometimes are operated at internal pressures considerably above 100 psi. In such cases, the possible effect of the higher pressures should be taken into account.

Internal pressure acts against the gasket in two ways:

1. *Hydrostatic end force.* This tends to move the flanges apart and is proportional to the internal pressure. The extent to which this happens, of course, determines how much the load on the gasket is reduced, and how much the risk of leakage is increased.

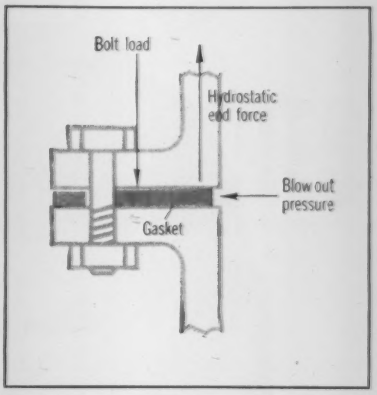
2. *Blowout pressure.* The sealed fluid or gas exerts direct pressure on the inside perimeter of the gasket. If this pressure is high enough, it will blow the gasket out of the joint.

The effect of high internal forces must be compensated for in the design of the joint. The obvious first step is to be sure that the flanges are capable of imposing the required unit load on the gasket. This involves the rigidity of the flanges and the number of bolts, their size, spacing, and torque values.

The second step is evaluation of the gasket material to be used. High unit loads dictate the choice of a material that will not extrude or rupture under high pressures. This usually means a dense fiber or asbestos material. Several compositions suitable for service under high flange loads are available in the Armstrong Accopac line of beater-saturated gasket materials.

Other factors such as the nature of the contained fluid and the temperature at the gasket line also have a bearing on the selection of a gasket material for service where internal pressures are high.

In summary, where internal pressures are involved, it is especially desirable to consider the joint as a unit. The flange design, the gasket material, the confined fluid, and the temperature should be considered in relation to each other.



Detailed information on the effect of internal pressures and other problems of gasket selection, design, and performance are included in the new Armstrong Gasket Design Manual. Write today for your copy of this helpful 32-page book.

Send today for your copy of new Gasket Design Manual, IND-763. Write Armstrong Cork Company, Industrial Division, 7110 Dean Street, Lancaster, Pa.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

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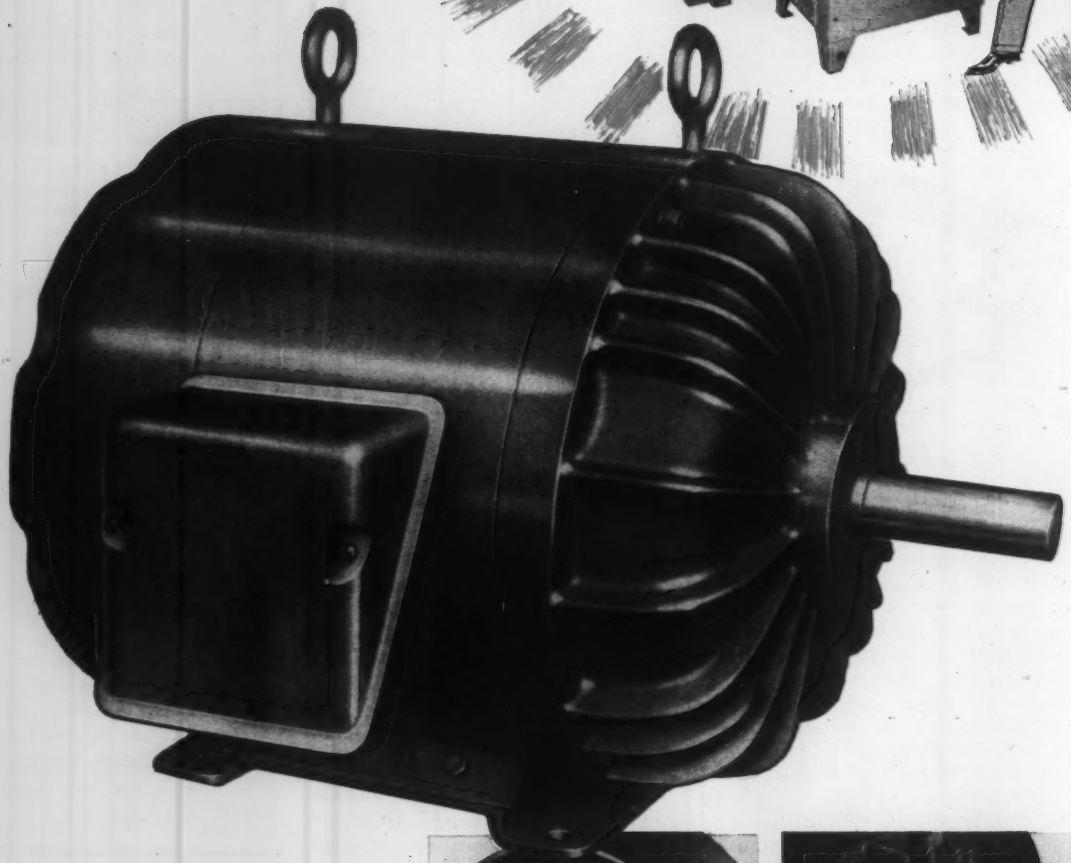
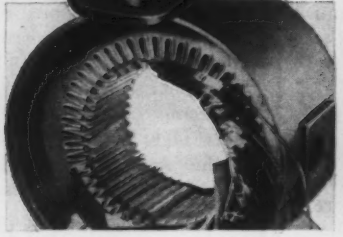
Udylite's

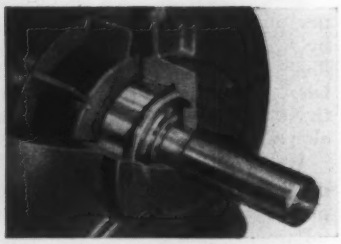


Robbins & Myers
build motors from
1/200 to 200 horsepower



MYLAR* INSULATION INCREASES MOTOR LIFE . . . insures positive insulation. Rag paper backing provides cushioning effect against abrasions and punctures. Entire motor winding is pre-heated, twice dipped in varnish and baked after each dip.

*DuPont registered trademark



BEARINGS POSITIVELY SEALED . . . Double row width ball bearings, sealed on both sides, eliminate frequent re-lubrication. Grease sealed in extra-large reservoirs, resists dust, temperature, humidity and high operating speeds.

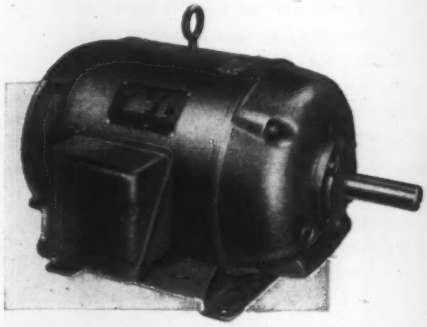
"shining example" shows how...

R&M TOTALLY ENCLOSED FAN COOLED MOTORS BEAT CORROSIVE ATMOSPHERES

Udylite Corporation's famed Automatic Plating Machines put a shine on everything from sewing machine parts to automobile bumpers. R&M Totally Enclosed Fan Cooled Motors power the hydraulic system of these precision machines quietly, smoothly and without vibration. But most important they successfully combat the severe corrosive atmosphere common to all plating operations. R&M Motors are completely protected against this serious motor menace.

Complete R&M motor protection includes careful dipping, baking and painting of all steel parts . . . spraying of rotor and shaft with special rust-inhibitor . . . application of anti-corrosion primer to cast-iron end-heads and terminal box. A cast aluminum fan provides effective cooling by forcing air between enclosed internal and open external shells over motor's entire length. Other important features contributing to long-life protection and vigorous performance are described at left, below.

Robbins & Myers Totally Enclosed Motors range from ½ to 125 hp. Write today for Bulletin 500 MD



OPEN PROTECTED MOTORS . . . R&M open protected motors to 200 horsepower are suitable for many applications formerly requiring totally enclosed construction. Investigate this economical possibility for your application. Write for free Bulletin 520.

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

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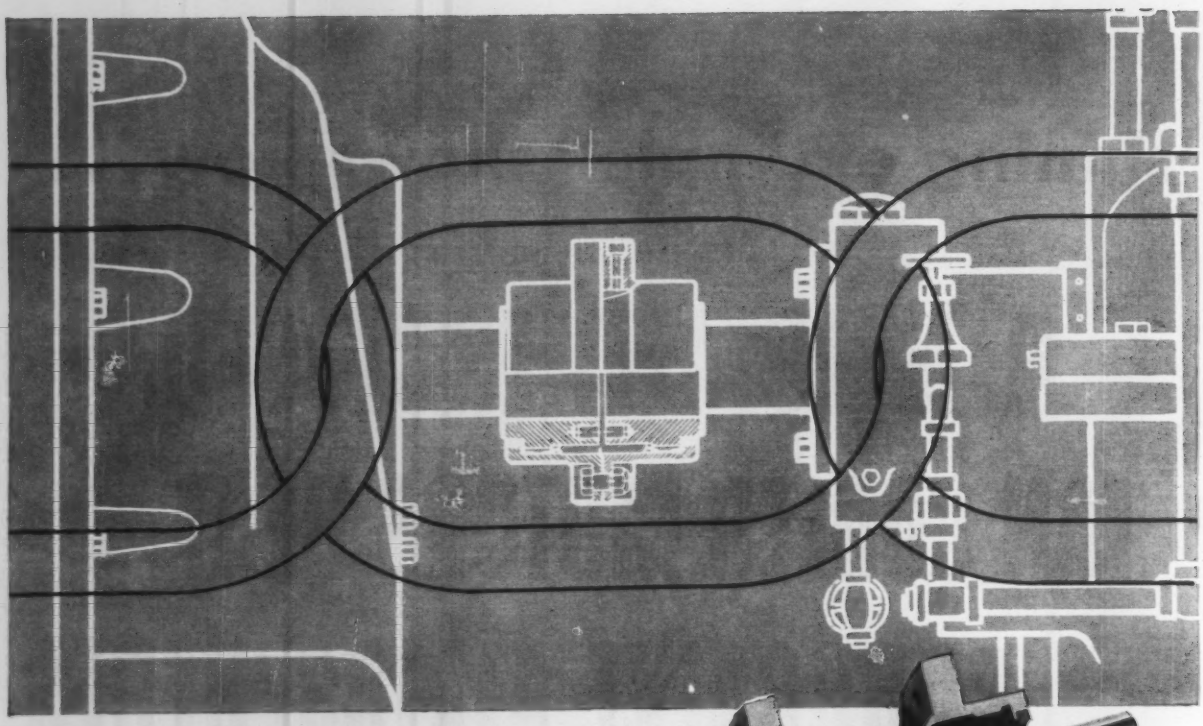

FOR WELL-DESIGNED EQUIPMENT...

SPECIFY THIS

POWER LINK

When a lot of time and effort have gone into the design of a piece of driven equipment, it makes sense to pick the power link carefully. Take a pump or compressor, for instance. No matter how well it is designed and built, for long service life and operating efficiency, it needs protection against strains due to misalignment.

Waldron gear couplings provide complete protection and positive, trouble-free drive because

They are strong . . . Hubs and cover sleeves for sizes 1¼A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

They are reliable . . . There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is at the lowest possible diameter where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

They are available . . . Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

Ask for Catalog 57

JOHN WALDRON CORP.

A subsidiary of Midland-Ross Corporation

NEW BRUNSWICK, NEW JERSEY

Representatives In Principal Cities
Export Agents—Frazar & Co., New York, N. Y.

MR

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Waldes Truarc Prong-Lock Ring Eliminates Springs, Washers, Takes Up End-Play

WALDES TRUARC
SERIES 5139 RETAINING RING*

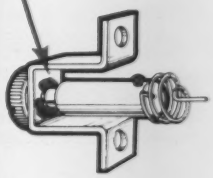
application: external for shafts
range: 3/32" through 7/16"

*U. S. Pat. No. 2,755,698

After radial application, the Waldes Truarc Prong-Lock retaining ring locks and holds securely in its groove by means of two prongs. Because of its resistance to radial displacement, the ring may be used as a shoulder for rotating parts. Thrust-load capacity ranges from 80 to 700 lbs. for sizes from 3/32" to 7/16". Bowed construction provides end-play take-up, often eliminating springs, washers and accessory devices.

Rings replace cotter pins, spring-washers; save $68.00/M

Mason-Neilan Division of Worthington Corp., Norwood, Mass., uses two Waldes Truarc Series 5139 Prong-Lock rings on its pressure controller to secure pivots through which a right angle micrometer adjustment screw passes. Each ring replaces hairpin-type cotter pin and bowed washer. . . provides necessary tension to prevent adjustment screw from shifting. Manufacturing costs were reduced by $68 per 1,000 units.



Ring replaces locknut, eases control calibration

On a differential pressure control mechanism, Taylor Instrument Companies, Rochester, N. Y., replaced a locknut and eliminated a costly threading operation with a series 5139 Prong-Lock ring. Also eliminated is the loosening and tightening of the locknut before and after each calibration setting. Spring action of the ring securely holds the calibration setting.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get:

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

e 1

WALDES
TRUARC®
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me additional information and engineering data for the Truarc Prong-Lock Ring, Series 5139.

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

MD-100

Consult the Yellow Pages of your Telephone Directory for name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

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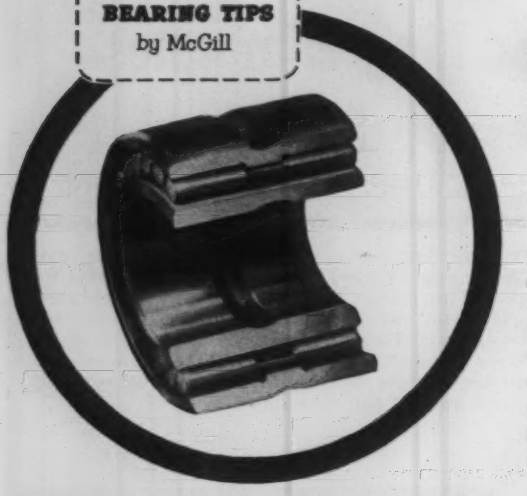
Circle 438 on Page 19

BEARING TIPS
by McGill



GUIDEROL® needle roller bearings save space and simplify design

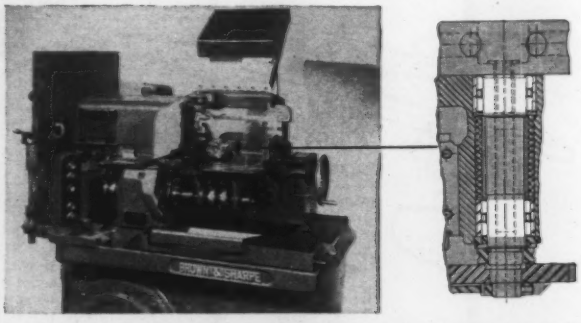
. . . especially where their greater capacity can reduce the size and cost of an adequate bearing housing. More and more designers are specifying McGill GUIDEROL bearings to carry heavier loads dependably with smaller bearings.

GUIDEROL bearings combine full type bearing capacity with center guided rollers that limit skewing and eliminate the possibility of binding under average misalignment. Especially suited to vertical mounting.

These precision heavy duty needle roller bearings are available with or without inner races in shaft sizes from ⅜" to 9¼". Specify the sealed series to keep out contamination and avoid relubrication.

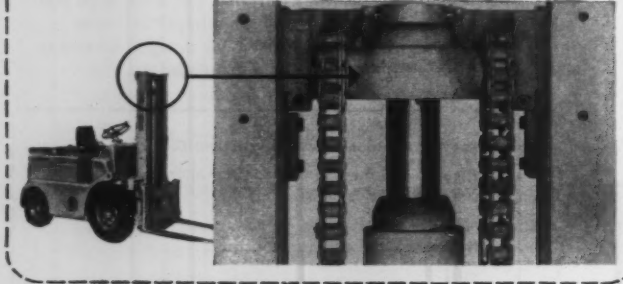
Minimum clearance, maximum load capacity retained in automatic screw machine

BROWN & SHARPE MFG. CO. replaced plain scraped bushings in the turrets of their No. 00 Automatic Screw Machines with McGill GUIDEROL bearings.
GUIDEROL bearings were selected to retain minimum clearance and maximum load capacity. In addition to meeting these requirements, the GUIDEROL eliminated production problems involved in the use of the scraped tapered bushings. The bearings support the turret during cutting and indexing operations. GUIDEROL design also satisfies the need for maintaining accurate alignment throughout long machine life.

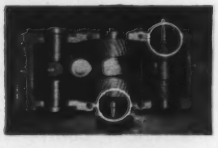


High capacity and compactness in lift truck chain cross-head rollers

GUIDEROL bearings support TOWMOTOR 6000 through 11,000 pound capacity lift truck payloads. They are used as chain crosshead roller bearings. Space requirements and the need for high capacity without the "walking" tendency of a straight needle roller bearing led to the selection of GUIDEROL bearings. GUIDEROL bearings have been rated very well in terms of length of life, maintenance and load carrying capacity in this application. Performance is rated excellent. The user reports reduced service requirements as compared with straight needle bearings formerly used.



Design simplified in mine machine transmission



Manufactured by the LONG Company, "PIGLOADER" coal loading machines feature full independent crawler control with a single motor. Application of GUIDEROL bearings on the tram clutch shaft is typical of other McGill bearing applications on the loader. GUIDEROL CT series bearings are used on the output end of the shaft to handle purely radial loads in small radial space. On the opposite end of the shaft, double row ball bearings handle combined thrust and radial loads. This combination eliminates the need for complicated adjustments. Use of a roller bearing, which has the same dimensions as the thrust bearing, accomplishes the design purpose with minimum machining variation in the transmission case. The GUIDEROL equipped tram transmissions allow each crawler to operate independently, a substantial design improvement.

engineered electrical products

McGILL®

precision needle roller bearings

SEND FOR CATALOG No. 52-A

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- Couplings designed to exceed minimum *burst* pressure —four times actual working pressure.
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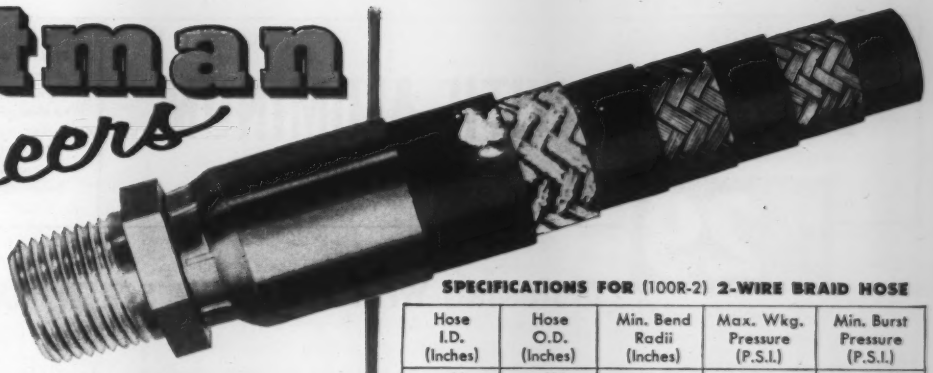
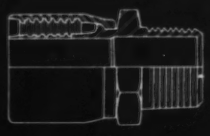


SPECIFICATIONS FOR (100R-2) 2-WIRE BRAID HOSE

Hose I.D. (Inches)	Hose O.D. (Inches)	Min. Bend Radii (Inches)	Max. Wkg. Pressure (P.S.I.)	Min. Burst Pressure (P.S.I.)
¼	11/16	4	5000	20000
⅜	27/32	5	4000	16000
½	31/32	7	3500	14000
¾	1¼	9½	2250	9000
1	1⅝	9½	1875	7500
1¼	2	16	1625	6500
1½	2¼	20	1250	5000
2	2¾	22	1125	4500

PERMANENTLY ATTACHED COUPLINGS

For 2-wire braid hose. Offers maximum coupling strength, strong hose attachment and improved orifice for rapid, friction-free fluid flow. For working pressures up to 5000 psi. See Pages 10 and 11.



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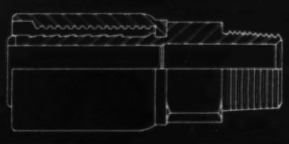
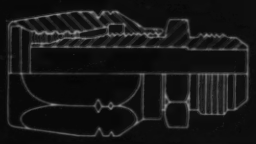
For EXTREME high pressures up to 7000 psi working pressure. Eastman engineered for greater power delivery and performance. For specifications and sizes, send for New Eastman Bulletin 200, below.



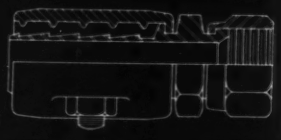
2 PIECE REUSABLE COUPLINGS

For 2-wire high pressure hose up to 5000 psi working pressure. Increases serviceability of your equipment through easy replacement in the field. See new Bulletin for complete details.



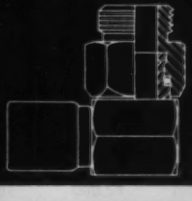
CLAMP TYPE COUPLINGS

Accurate machining assures alternate positioning of clamp ribs between each barb of insert—creating exclusive Inter-Lock grip—available to you only through Eastman. Pages 14 and 15.



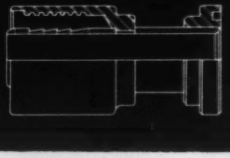
SWIVEL "O" RING MALE COUPLINGS

Permits easy assembly in close quarters, easy positioning of hose in 45° and 90° angles. Economical, reduces number of threaded connections. Dimensional drawings, sizes, and specifications in new Bulletin.



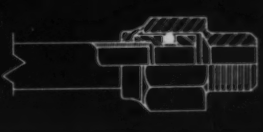
FLANGE HEAD COUPLINGS

Offer advantages of permanent hose attachment plus Split Flange Head Couplings with 0° to 90° stems. Economy plus user convenience. Specifications and sizes listed in new Bulletin.



TUBING ASSEMBLIES

Swivel Male "O" Ring Tube Nut used on tubing assemblies. Eastman offers formed tubing with beaded or flared ends—to your requirements. Specifications and sizes on Page 30.



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Circle 440 on Page 19

DESIGNING WITH ALUMINUM

NO. 29

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

DESIGNING WITH ALUMINUM SCREW MACHINE PRODUCTS

RECENT INNOVATIONS in screw machine equipment have made possible great strides in the accuracy, versatility and output rates of both single and multiple spindle machines. These advancements, such as spindle-stopping attachments, increased spindle speeds and numerous secondary-operation accessories, along with the superior working qualities of improved aluminum alloys, have created new opportunities for the designer of precision, high-volume production parts.

Advantages of the Screw Machine Process

The screw machine process serves two primary design considerations: high quality and low production cost. Thus, whenever design of the parts permits, screw machining is usually chosen in preference to other fabricating methods.

High quality of product is, in part, the result of high quality starting materials. The rod, bar and wire used in screw machine work is wrought during the forming process, thus acquiring good density, low porosity and fine grain structure. These properties are conducive to excellent machinability, faithful detail and fine surface finish.

Materials having these properties, when worked in a process of inherently high accuracy and close control, produce parts of dependable dimensions and great uniformity. Accurate concentricity and mating-part fits are attained, with closer tolerances possible than in any other primary fabricating method. For example, Class 3 threads, and other features of similar fineness, may be turned without undue difficulty.

The properties contributing to high quality also contribute to low production cost. Fewer secondary operations are necessary, because of the fine as-machined surface finishes, the intricacy of detail and the dimensional accuracy possible in the basic screw machine process. Rejection rates are low, and subsequent automatic handling processes are facilitated by the uniformity of the parts.

Reduced unit costs also stem from the wide range of available high speed equipment and mill-standard raw materials, the relative simplicity of machining set-up and the faster delivery of finished parts. Expensive dies and fixtures are not required. And because stock cutting tools generally may be used, tooling and maintenance costs are minimized. In-process modification of parts is relatively quick and easy.

Added Advantages with Aluminum

The designer will find these native features of the screw machine process even more valuable when the physical and mechanical advantages of aluminum are considered.

Fig. 1

TYPICAL PROPERTIES OF ALUMINUM SCREW MACHINE ALLOYS COMPARED WITH STEEL AND FREE-CUTTING BRASS

	Tensile Strength (psi)	Yield Strength (psi)	Shear Strength (psi)	Elongation (% in 2 in.)	Hardness (Brinell)	Modulus of Elasticity (psi)	Density (lb./cu. in.)	Electrical* Resistivity	Thermal† Conductivity	Thermal Expansion (68 to 580 F.)
B1113 Steel (Cold Drawn)	85,000	75,000	—	14	170	29.0×10^6	.283	20.0	360	12.8×10^6
C1018 Steel (Cold Drawn)	82,000	70,000	—	20	163	"	"	"	"	"
B1112 Steel (Cold Drawn)	82,500	71,000	—	15	170	30.0×10^6	"	"	"	"
#271 Brass (Free Cutting)	58,000	45,000	34,000	25	143	14.0×10^6	.307	6.6	800	20.5×10^6
ALUMINUM ALLOYS										
2011-T3	55,000	43,000	32,000	15	95	10.2×10^6	.102	4.8	990	22.9×10^6
2011-T8	59,000	45,000	35,000	12	100	10.3×10^6	.102	4.8	990	
2014-T4	62,000	42,000	38,000	20	105	10.6×10^6	.101	5.7	840	23.3×10^6
2017-T4	62,000	40,000	38,000	22	105	10.5×10^6	.101	5.7	840	23.5×10^6
2024-T4	68,000	47,000	41,000	19	120	10.6×10^6	.100	5.7	840	23.2×10^6
6061-0	18,000	8,000	12,000	30	30	10.0×10^6	.098	3.8	1190	23.5×10^6
6061-T4	33,000	21,000	24,000	25	65	10.0×10^6	.098	4.3	1170	
6061-T6	45,000	40,000	30,000	17	95	10.0×10^6	.098	4.3	1170	
7075-T6	83,000	73,000	48,000	11	150	10.4×10^6	.101	5.7	840	23.6×10^6

*In microhms/cm. at 68 F. †In B.T.U. per inch per square foot per hour.

While almost all aluminum alloys are well adapted to machining, a number of them are especially designed for turn-cutting operations. The wide range of these alloys permits matching the characteristics of the alloy to the working requirements of the part. Some aluminum alloys provide strength properties approaching those of cold-drawn mild steel. Others have machining qualities equal to free-cutting brass. All have good corrosion resistance under proper conditions of use.

Alloy 2011, for example, the most popular aluminum alloy for screw machined products, is an especially free-machining metal with excellent mechanical properties, accepting heavy feeds at high cutting speeds. This alloy, and some of the other aluminum alloys available for the designer's selection of optimum property combinations, is listed in Fig. 1 along with representative brass and steel materials.

Alloy 2017, which like 2011 is one of the most frequently selected aluminum alloys for screw machine work, has somewhat higher ductility than 2011, while retaining good machining qualities.

Strongest of these copper-bearing aluminum alloys is 2024, which can be readily roll-threaded, spot welded and finished to fine surface qualities. It is widely used for durable fittings and fasteners.

The 6061 and 7075 alloys listed in Fig. 1 illustrate the versatility of aluminum for screw machine product applications. Note that 6061, for example, increases five-fold in yield strength from its annealed condition to its T6 temper stage, which is attained simply by heat treating. This 6061 material is readily welded by all methods, may be torch or furnace brazed, and has good resistance to corrosive attack as well as excellent machinability.

Alloy 7075 offers the strength qualities of cold-drawn steel *at one-third of the weight per volume* in an easily machined, spot weldable material.

More Helpful Design Properties

In addition to their qualities of superior machinability and high strength-to-weight ratio, these aluminum alloys offer many other properties helpful to the screw machine product designer.

For electrical usages, aluminum alloys offer conductivity, in proportion to weight, ranging up to double that of electrolytic copper. Similarly, thermal conductivity is higher than in free-cutting brass and three or four times greater than in ferrous metals. This quality affords quick, even distribution of heat, where heat is desired, while providing rapid dispersion of undesirable heat. Thus, aluminum terminals, fittings and other parts designed for screw machine fabrication are of great value in electrical equipment, appliances and other high-volume production items.

Another unique property of aluminum, valuable to many modern designers, is its retention of structural strength at low temperature levels. Aluminum alloys actually increase in tensile strength and elongation, without embrittlement, as temperatures drop. The increasing demand for precision fittings and accessories in liquid-gas fueled missiles, for example, gives great significance to this unusual feature of aluminum for screw machine parts.

Still another valuable design property of aluminum is superior resilience under stress, especially in the stronger alloys, due to low modulus of elasticity. In a component subject to normal operating loadings, not involving excessive impulsive shocks or fatigue effects, the ability, "U," of a metal to absorb energy from tensile or compressive strains may be expressed as:

$$U = V\frac{S^2}{2E}$$

where stress S, in psi, does not exceed yield strength; V is the volume of metal under this stress; E is elastic modulus.

The relative capacity of aluminum to absorb energy may then be observed, for equal volumes and equal elastic strengths, as the simple ratios:

$$\frac{U\ \text{aluminum}}{U\ \text{brass}} = 1.36, \text{ and } \frac{U\ \text{aluminum}}{U\ \text{steel}} = 2.91$$

For equal elastic strengths and equal weights:

$$\frac{U\ \text{aluminum}}{U\ \text{brass}} = 4.1, \text{ and } \frac{U\ \text{aluminum}}{U\ \text{steel}} = 8.1$$

(Equations derived from values in table below—taken from ASM Metals Handbook.)

Metal	E (psi)	Density lbs./cu. in.
Aluminum (2011)	10.3×10^6	.102
Free Cutting Brass	14×10^6	.307
Steel (B1112)	30×10^6	.283

Variety of Finishes Applicable

Among further advantages of aluminum screw machine products is the great variety of mechanical, chemical and electro-chemical finishes applicable to these alloys. While aluminum screw machining alloys have attractive natural appearance, artificially induced finishes may be preferred or required for many applications.

Decorative effects may be obtained by permanent color anodizing or by applied coatings. Other finishes are used to reduce non-lubricated friction between moving surfaces in contact, to improve resistance against abrasion and corrosion, to provide better adherence of paints or adhesive materials, and for many other reasons. Some of these available finishing processes are described in Fig. 2 on following page.

Some means of corrosion protection may be required when aluminum screw machine products are used in contact with dissimilar metals in a corrosive environment. Various means may be used to provide this protection.

Aluminum Offers Cost Advantages

Further help in solving the designer's problems in production economy is offered by the behavior of aluminum in shop handling and machining. The mill-standard starting materials are available, in broad size ranges, from distributor stocks throughout the country. Providing three times as much volume per pound as heavier common commercial metals, aluminum use reduces freight and shop handling costs for both raw materials and finished products. Natural corrosion resistance reduces or eliminates need for special protective attention under storage.

In the machining process, aluminum materials offer more rapid dissipation of heat, long tool life and greater stability of as-machined finish. The lightweight, finely-divided chips are easy to remove from production parts and machinery. Thus, the advantages of designing with aluminum alloys are found in all phases of cost, convenience, fabrication and function.

What the Designer Conceives... Aluminum Achieves

To help designers make full use of up-to-date developments, the following

Circle 441 on Page 19

Fig. 2

SOME AVAILABLE FINISHES FOR ALUMINUM SCREW MACHINE PRODUCTS

Type of Finish	Name of Finish	Principle Purpose of Finish
Mechanical	Grinding	To remove surface imperfections.
	Polishing, buffing and coloring	To remove surface imperfections and to achieve decorative finish.
	Scratch brushing	To obtain a coarse- or smooth-lined texture.
	Satin finish	To obtain a soft, smooth sheen.
	Burnishing	To impart fine finish to a large number of small parts.
	Sand blasting	To produce a uniform matte surface.
Chemical	Caustic Etch	Decorative "frosted" finish.
	Crystalline chromate	Paint base.
	Chromate-phosphate-fluoride	Paint base.
	Phosphoric acid	Paint base.
	Chemical polishing	Bright finish or base for anodizing.
	Zincate	Base for electroplating.
Electrolytic Oxide	Sulfuric acid anodize	Hard, corrosion-resistant oxide film, base for dyed coatings.
	Chromic acid anodize	Hard, corrosion-resistant oxide film.
	*Hard anodizing	Extremely hard, corrosion- and wear-resistant film.
	Electrolytic polish	High light reflectivity.
Electroplating	Chromium plate	Abrasion-resistant and decorative.
	Copper plate	To promote solderability, decrease electrical surface-resistance.
	Silver plate	Decrease surface resistance.
Painting	Paint, lacquer, enamel	Decorative, corrosion resistant.
	*Porcelain enamel	Hard, decorative, corrosion-resistant coatings.

*For use only with 6061 aluminum alloy.

checklists summarize the advantages of modern screw machine production and the advantages of aluminum:

12 Advantages of Screw Machine Production

1. Starting material is a wrought product which gives high properties in the finished part.
2. Very fine threads possible—as well as accurate threading.
3. Excellent finishing possibilities—anodizing, etching, buffing, etc. As-machined finish gives very fine surface.
4. Closer tolerances and more intricate parts possible than with other methods. Mating parts match better.
5. Excellent concentricity is guaranteed.
6. Fewer rejects for porosity when compared to a cast part.
7. Lower costs for production tooling, dies, set-up; faster delivery of finished parts possible due to fast availability of tooling, speed of set-up.
8. Modification of parts in production easier and less costly.
9. Wide range of equipment and facilities available throughout the country.
10. Fewer secondary operations necessary; possible to avoid secondary finishing by using the as-machined surface.
11. Lower costs for actual production due to high rates of production with available new equipment.
12. Lower costs for finished parts due to competitive pricing among large number of suppliers.

12 Advantages of Aluminum

1. Light weight—moving parts present less resistance to applied force, wear less; chips float out of recesses better for cleaning finished parts. Easier handling of raw material in plant, lower freight costs on finished parts.
2. Non-magnetic.
3. Corrosion resistant—can often eliminate finishing.
4. Non-sparking.
5. Lower raw material cost per part.
6. Greater conductivity—helps dissipate machining heat.
7. Some alloys less susceptible to radiation absorption.
8. More alloys available than some other metals, allowing a particular alloy to be related to a particular part.
9. Less price fluctuation on raw materials.
10. Stock readily available. Size range broad and well stocked at distributors throughout the country.
11. New procedures in producing aluminum screw machine stock now give greater tool life and higher production. New processes such as Electrofilming and Kanigen Coating have overcome old problems as galling and binding.
12. Technical literature for designing purposes readily available.

Engineering advisory services and technical literature on conversions to aluminum in screw machining are available without obligation to interested manufacturers. For further information and professional design assistance, inquire through the Kaiser Aluminum sales office listed in your telephone directory.

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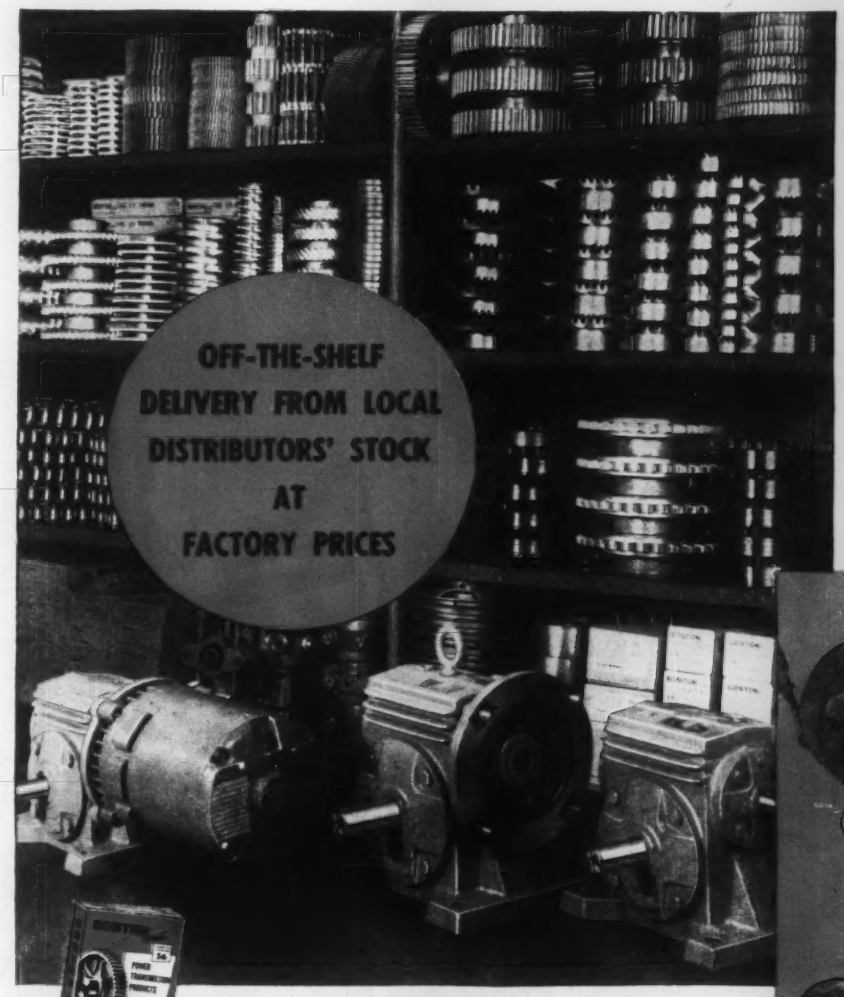

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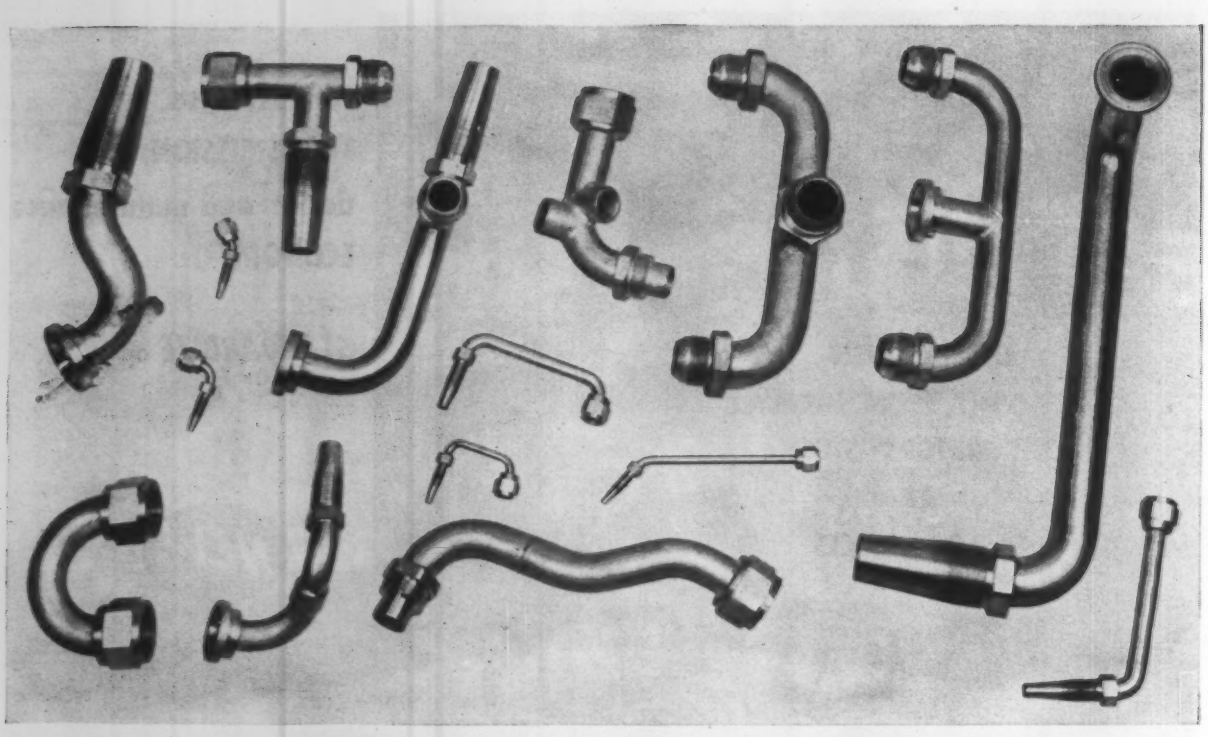

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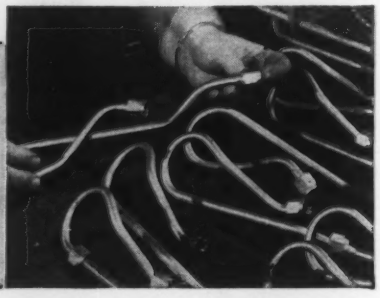
Submit your fluid line problem to our sales engineering department and mail the coupon below for our precision tube forming Catalog No. 500.

ABOVE—Fittings for this steel tube configuration are being arc welded with an inert gas shield to produce a sound, more uniform weld. Five different welding or brazing processes for tubing are available at Aeroquip.

BELOW—Volume production of this 5-bend tubing configuration was made possible by the development of unique tube-forming equipment by Aeroquip engineers.



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Please send me a copy of Catalog No. 500 on Aeroquip Precision Tube Forming facilities

NAME_____

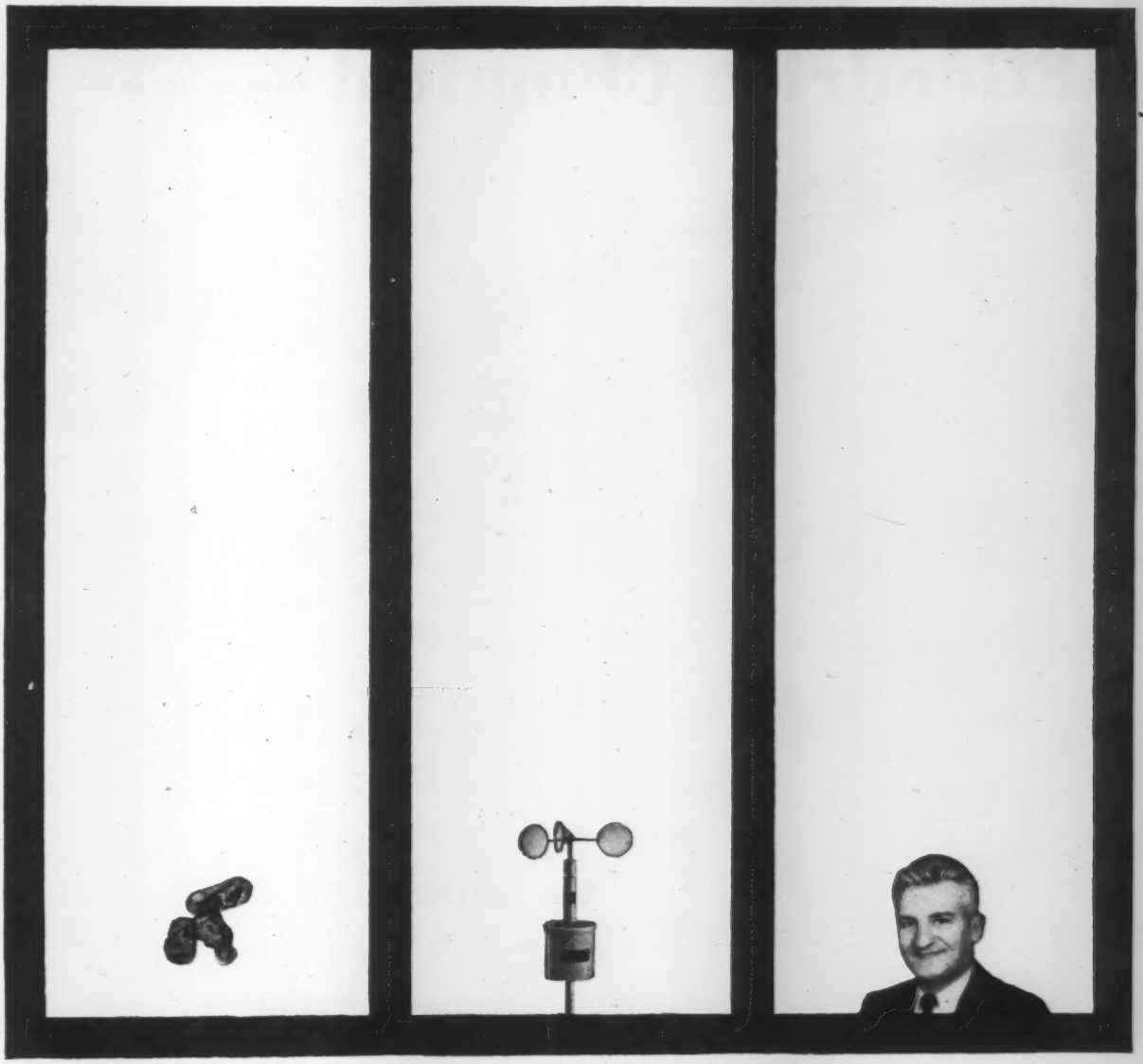
TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

Circle 444 on Page 19



Miracle Plant! Zoospores of some fungus cover their own length as fast as a Sabrejet. The bacterium *Pseudomonas aeruginosa* (shown many times its size) has been clocked at 31.7 lengths per second. To do as well, proportionate to size, a man would have to run 125 miles an hour.

Miracle Instrument. This anemometer catches a puff of wind wafting less than 1 mile per hour. Its high sensitivity and accurate measurement of wind speed are aided by two MPB bearings in which the shaft rests. Quick starting is result of low initial torque.

Man With Miracles. This is Nick Carter, MPB's Chief Engineer. He helped the anemometer people find exactly the right type of radial retainer bearing that would reduce friction to a minimum, give failure-proof service and help keep original and maintenance costs low.

Miracles in Miniaturization

ACTUAL SIZE

New Age Of Miracles is miniaturization in industry. It's a new frontier as magnificent as the colossal. With MPB bearings the impossible miniaturization often becomes practical; the pretty-good becomes perfect. MPB has the greatest wealth of experience in miniaturization in the bearing industry . . . over 500 types and sizes available . . . specials on request . . . technical assistance and research facilities second to none. You'll want to know more about the subject. For our new catalog write **Miniature Precision Bearings, Inc.,** 113 Precision Park, Keene, N. H.

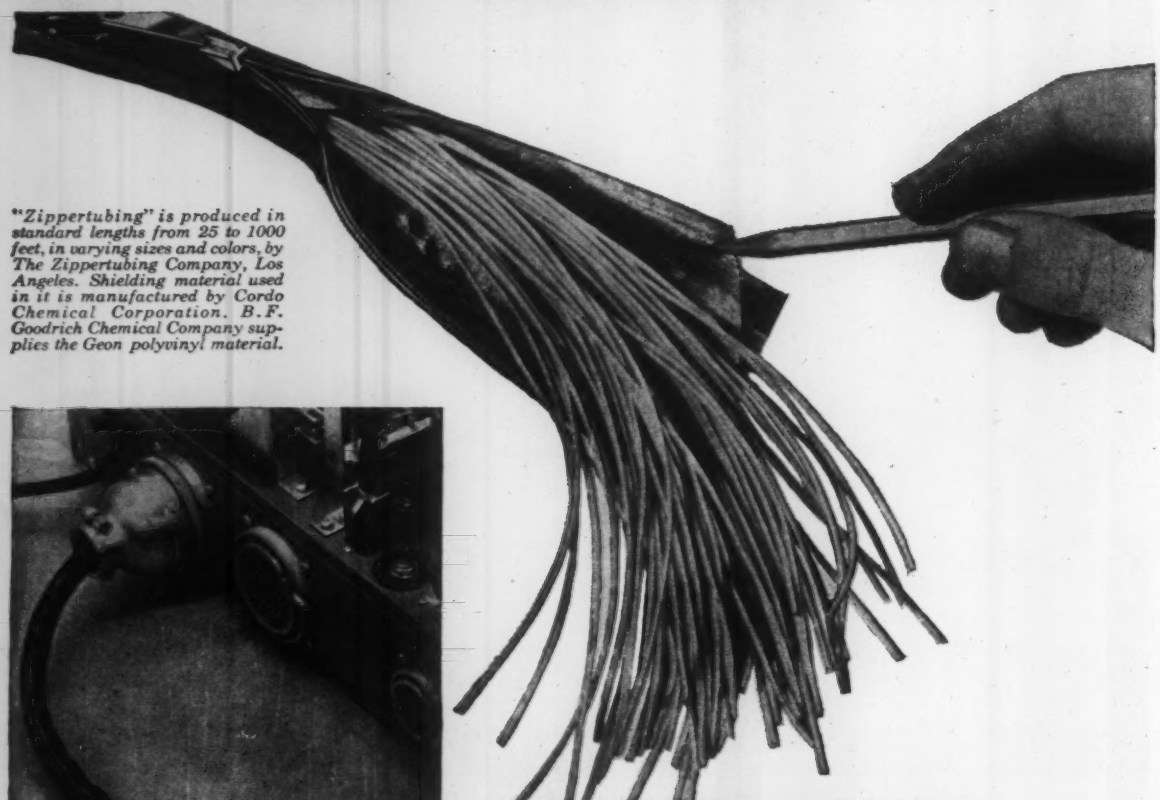
MPB

Helps you perform miracles in miniaturization

Circle 445 on Page 19

Another new development using

B.F.Goodrich Chemical *raw materials*



"Zippertubing" is produced in standard lengths from 25 to 1000 feet, in varying sizes and colors, by The Zippertubing Company, Los Angeles. Shielding material used in it is manufactured by Cordo Chemical Corporation. B.F. Goodrich Chemical Company supplies the Geon polyvinyl material.

New shielding and jacket made with Geon can be zipped on in a single operation

Production and maintenance of wire harnesses are greatly simplified with this new shielding and jacket combination made with Geon polyvinyl material. All you do is zip it on. Saves time and equipment during manufacture—makes it easy to replace the jacket if it has to be removed to get at wiring for service.

For regular RF shielding, glass cloth saturated with Geon polyvinyl material is laminated to aluminum foil. It gives 100% coverage to provide immediate grounding of RF and UHF interference. The outer surface, also of Geon, has zipper tracks sealed in. A pull tab can easily be used to facilitate closure.

For heavier magnetic shielding, special steel foil is laminated between layers of Geon. Lead saturated glass cloth is available for radiation problems.

Geon provides high insulation resistance, heat stability and extra strength, as well as accuracy in molding. It's another example of versatile Geon proving the key to a dramatic new product. For information, write B.F. Goodrich Chemical Company, Dept. LO-6, 3135 Euclid Avenue, Cleveland 15, Ohio.

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

SEE US AT BOOTH NO. 508
8TH NATIONAL
PLASTICS EXPOSITION
NOV. 17-21
INT'L AMPHITHEATRE—CHICAGO

B.F.Goodrich

GEON polyvinyl materials • HYCAR American rubber and latex
GOOD-RITE chemicals and plasticizers • HARMON colors

Circle 446 on Page 19

*exclusive feature of

U.S. MOTORS

Today's greases have different chemical bases—lithium, sodium, calcium, barium, and other bases which your people can't be expected to keep track of. Some of these greases will not mix safely with others. Because certain chemical bases may react with each other, mixed grease may change its characteristics and become unsuitable for bearing lubrication. That is why U.S. LUBRIFLUSH—an exclusive feature of U.S. Motors—is so important. With this transverse lubrication system, old grease is *completely* flushed out as new grease is forced in. There's no mixing. New grease can be put in without bothering to determine whether it's basically compatible with the old. LUBRIFLUSH, moreover, assures proper lubrication for longest bearing life. Another good reason to specify: "U.S. ELECTRICAL MOTORS."

U.S. ELECTRICAL MOTORS INC.

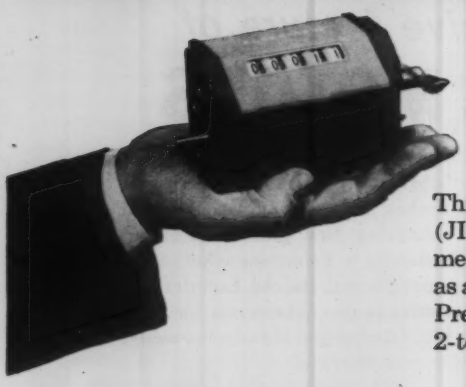
P. O. BOX 2058, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

FREE COLOR BROCHURE
...for full information send for FREE Lubriflush Bulletin.

Circle 447 on Page 19

Resets at a Finger-FLICK...

runs at speeds up to 8,000 counts per minute!



Here's a new Veeder-Root high-speed predetermining counter *with instant resetting*. Easily preset to the required number of pieces or performance-units, the counter subtracts to zero . . . *then resets with a finger-flick back to the original preset number.*

This new counter meets standard U. S. electrical requirements (JIC Codes) . . . and is available with either electrical switch or mechanical stop. Also available *without the predetermining feature,* as a high-speed reset revolution counter. Series 1522 High Speed Predetermining Counters come in a rugged, handsome 2-tone gray case that looks well everywhere. *Write:*

EVERYONE CAN COUNT ON

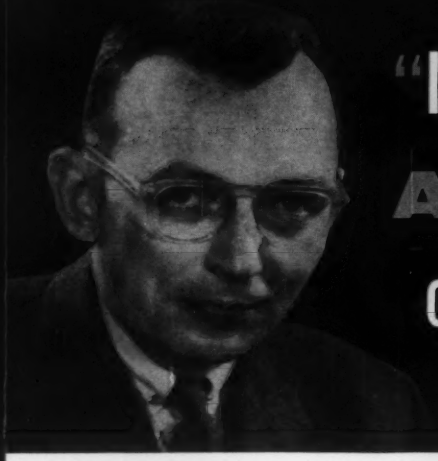
Veeder-Root
INCORPORATED
Hartford 2, Connecticut

*Trade-mark registration applied for.

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago • New York • Los Angeles • San Francisco • Montreal • Offices and Agents in Principal Cities

Circle 448 on Page 19

Circle 449 on Page 19→

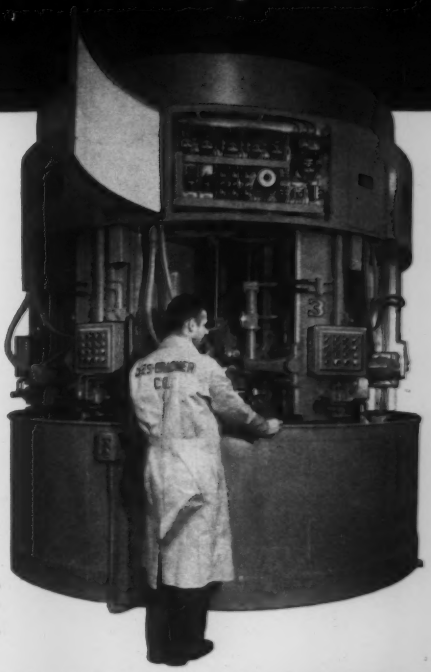


"If we stick to ALLEN-BRADLEY... our control troubles evaporate"

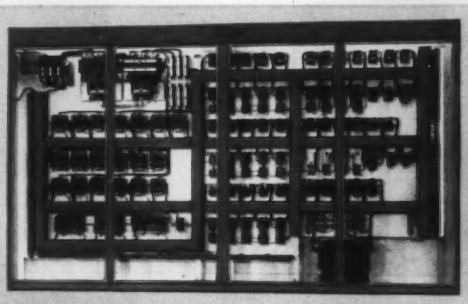
... so says John A. Bradner,
President, Lees-Bradner Co.,
Cleveland, Ohio, machine tool manufacturer.

"Yes, we have chosen Allen-Bradley controls. We use them, like them, and most thoroughly approve of them. We do our level best to see that they're the ones with which LEES-BRADNER machines are equipped.

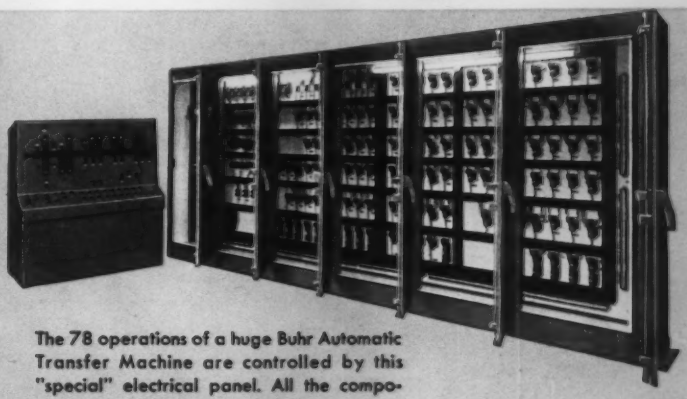
"It has been our experience in over 25 years of pioneering electrical rather than mechanical control of machine tools that, if we stick to Allen-Bradley, control troubles we are too apt to have otherwise—*evaporate!*"



Lees-Bradner Gear Hobbing Machine, above, uses six motor control panels assembled from standard A-B components.



This is the electrical control panel for a 12-station Kingsbury Indexing Automatic which performs 19 operations on an automatic transmission part. All the components in this panel are standard A-B control items.



The 78 operations of a huge Buhr Automatic Transfer Machine are controlled by this "special" electrical panel. All the components are standard Allen-Bradley units.

A-B QUALITY

ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

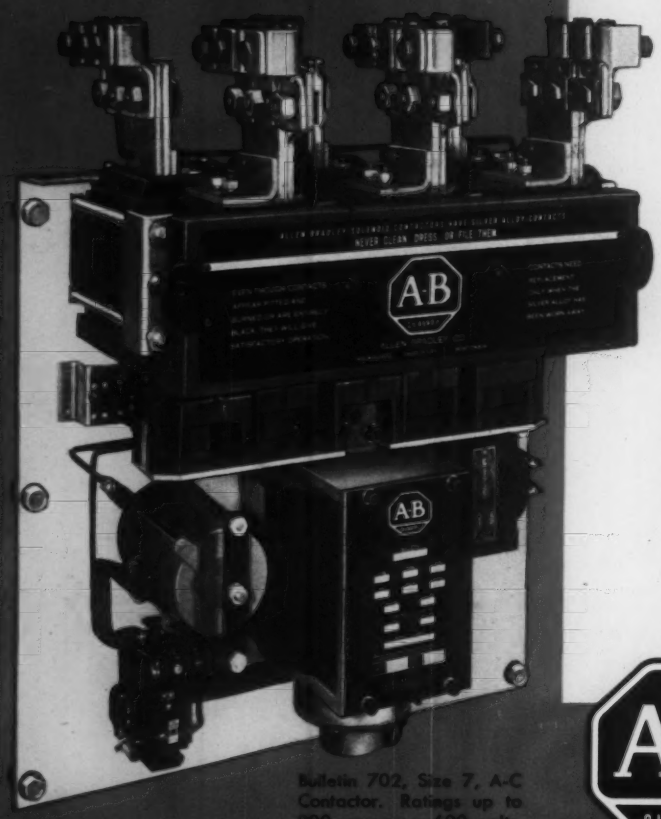
10-58-B

only

ALLEN-BRADLEY gives you Trouble Free Solenoid Starters in ALL SIZES!

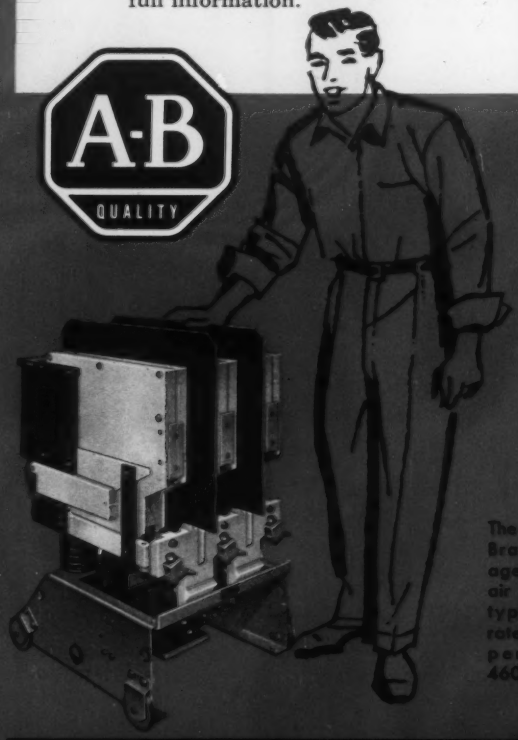
The simple solenoid design—exclusive with Allen-Bradley in the big starter sizes—has only one moving part. This eliminates the trouble causing bearings and flexible jumpers of conventional clapper switches . . . and assures millions of trouble free operations. A-B solenoid starters also have double break, silver alloy contacts that never need any servicing. They are always in perfect operating condition—until the contact is completely used up.

This time-tested solenoid construction is available on *all* Allen-Bradley starters up through Size 7 . . . as well as on A-B's rugged, air break, high voltage starters. Write for full information.

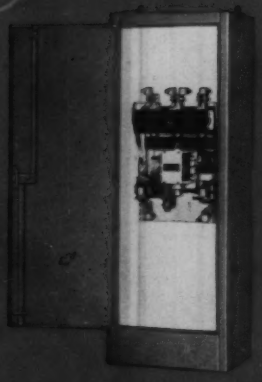


Bulletin 702, Size 7, A-C Contactor. Ratings up to 900 amperes, 600 volts. This basic solenoid contactor is used in large A-B low voltage starters.

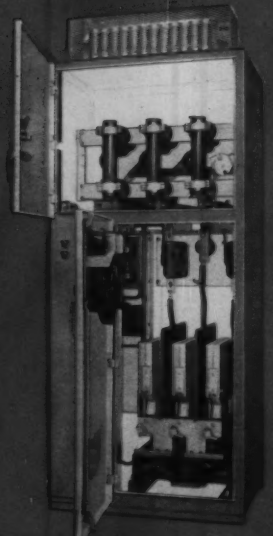
A-B QUALITY



The heart of Allen-Bradley high voltage starters is this air break, solenoid type contactor—rated at 400 amperes, 2300 or 4600 volts.



Bulletin 709 across-the-line solenoid starters are made in ratings to 300 hp, 220 v; 600 hp, 440-550 v.



A-B high voltage starters are built for all types of motors. Ratings to 1500 hp, 2300 v; 2500 hp, 4600 v.

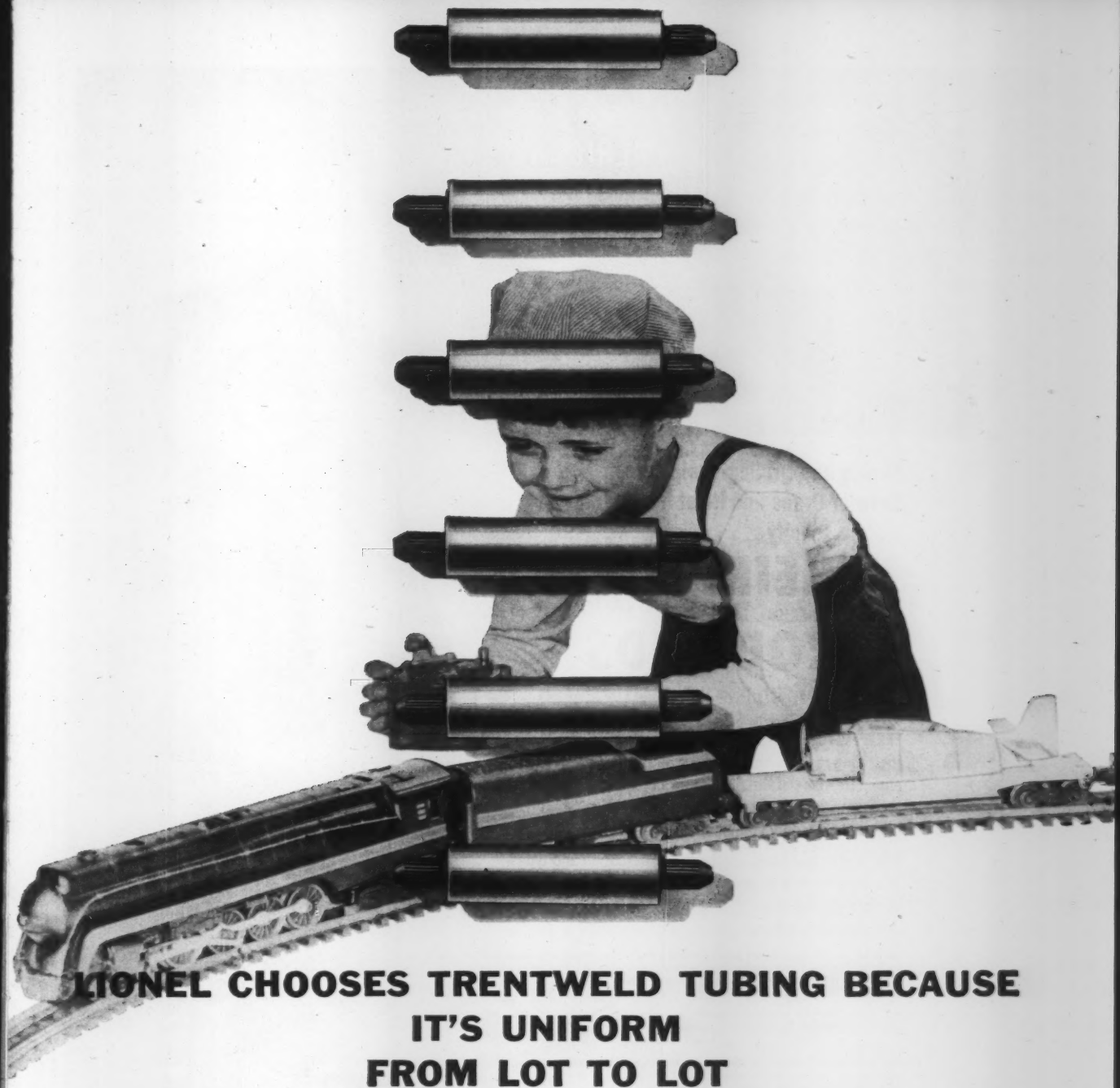
ALLEN-BRADLEY

MOTOR CONTROL

QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

10-58-MR



LIONEL CHOOSES TRENTWELD TUBING BECAUSE IT'S UNIFORM FROM LOT TO LOT

Going up a 20% grade, or rounding a a bend at the equivalent of a "grown-up" train's 180 mph., this Lionel steam locomotive securely hugs the track. The secret is a small magnet fitted neatly into the axle, which is made of Trentweld® tubing. Why Trentweld? Because its dimensions are always uniform from lot to lot. Costly center grinding is never necessary to make magnet and wheels fit properly.

Trent keeps its tubing uniform by checking all strip going into the welder for both width and tolerance. Furthermore, samples of each lot are tensile tested. Flattening, reverse bend, flare and flange, coil and pressure tests are conducted on all lots intended for corrosive applications. And a unique "single-wall" X-ray inspection is made as your final assurance of a sound, uniform product.

Trent tubing is made by an exclusive welding process – Contour Trentweld – which virtually eliminates the bead. By cold working and annealing after welding, Trent makes the weld itself as strong and corrosion-resistant as the parent metal.

Take advantage of Trent quality when you order tubing. And for further information, write for the Trent tubing handbook, Trent Tube Company, East Troy, Wisconsin.

CONTOUR TRENTWELD

TRENT TUBE COMPANY

A Subsidiary of Crucible Steel Company of America

GENERAL OFFICES: EAST TROY, WISCONSIN
MILLS: EAST TROY, WIS.; FULLERTON, CALIF.

Circle 450 on Page 19

Mining and Drilling Equipment, Crawler Crane and Hoist Manufacturers specify . . .

HEIM *Unibal*®
SPHERICAL BEARING
ROD ENDS

There are heavy duty Heim Unibal Rod End Bearings with BIG capacity and durability for use on unusually heavy linkages. They operate the compressed air clutch; they control the swing mechanism and the steering brakes; they help eliminate slack in the reverse swing and travel clutches, and contribute to the dependability and low maintenance of such heavy duty equipment.

The shapes and sizes, methods of fabrication and types of attachment to adjacent units are as varied as the number of installations. Heim Unibal is easy to install, easy to inspect, and easy to maintain.

No other device can correct misalignment better than Unibal, the spherical bearing. The maximum angle of misalignment for each of three types of mountings most commonly in use, is shown in this drawing . . .

For rod end applications in linkage mechanisms, other limiting factors may prevail, but the ability of the Unibal Rod End bearing to correct misalignment varies only in degree.

A wide range of stock sizes is available.

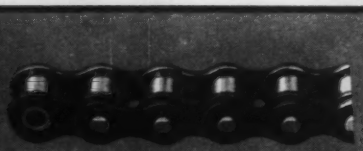
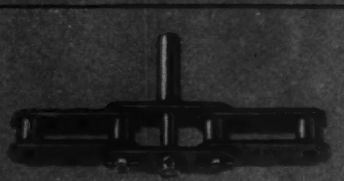
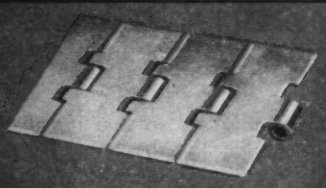
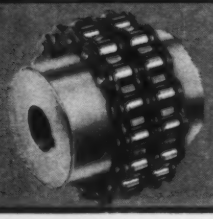
HEIM UNIBAL SPHERICAL BEARING ROD ENDS

Rod End	B	D	G	Maximum Static Radial Load
F Series	.1900 – 5000	.750 – 1.312	1.750 – 3.031	2,940 – 7,200 lbs.
M Series	.1900 – 2500	.750 – .938	1.935 – 2.969	1,695 – 3,723 lbs.
HF Series	.1250 – 7500	.469 – 1.750	1.046 – 3.750	1,201 – 11,326 lbs.
HM Series	.1250 – 7500	.469 – 1.750	1.172 – 3.750	452 – 11,326 lbs.
MFX Series	.2500 – 7500	.750 – 1.750	1.687 – 3.750	5,390 – 23,234 lbs.
HMX Series	.2500 – 7500	.750 – 1.750	1.937 – 3.750	5,390 – 23,234 lbs.

Components for Unibal Rod Ends are made of various suitable materials. Lubricators are supplied when specified. The Heim catalog gives complete specifications on all stock items; be sure to have one at your finger tips.

THE HEIM COMPANY • FAIRFIELD, CONN.

PUT MORE GO IN EVERY DRIVE WITH THIS ATLAS TRANSMISSION TEAM!

STANDARD ROLLER CHAIN		Complete line of Roller Chain ⅜" pitch through 2½" pitch—A.S.A. regular, heavy, single and multiple strand chain carried in stock. Alloy, Electrolized, bronze or stainless steel.
SPECIAL ROLLER CHAIN		Extended pitch, cable or sling chains, attachment chain or special chains to specifications. Atlas makes them all and stocks many sizes for quick deliveries.
PRECISION FITTED SPROCKETS		Complete line of precision made roller chain sprockets to A.S.A. specifications ⅜" pitch through 2" pitch carried in stock. Available in heat treatable steel, bronze, Electrolized and stainless steel.
CONVEYOR CHAIN		Atlas FLAT-VEYOR Chain and sprockets. Complete line of both Electrolized and carbon steel carried in stock. Also available in stainless steel upon order.
FLEXIBLE COUPLINGS		Complete line of steel chain couplings, carried in stock. Stainless steel, bronze and Electrolized are available made to order.

Atlas Roller Chain, Sprockets and Flexible Couplings are precision matched to operate as a power team for peak efficiency. They are made to run quieter, last longer and require less maintenance. They are a power team to provide higher efficiency and longer life on every type of installation.

ATLAS CHAIN & MANUFACTURING CO.
West Pittston, Pa.

Please send me data for designing more efficient power drives.

Name _____ Title _____

Company _____

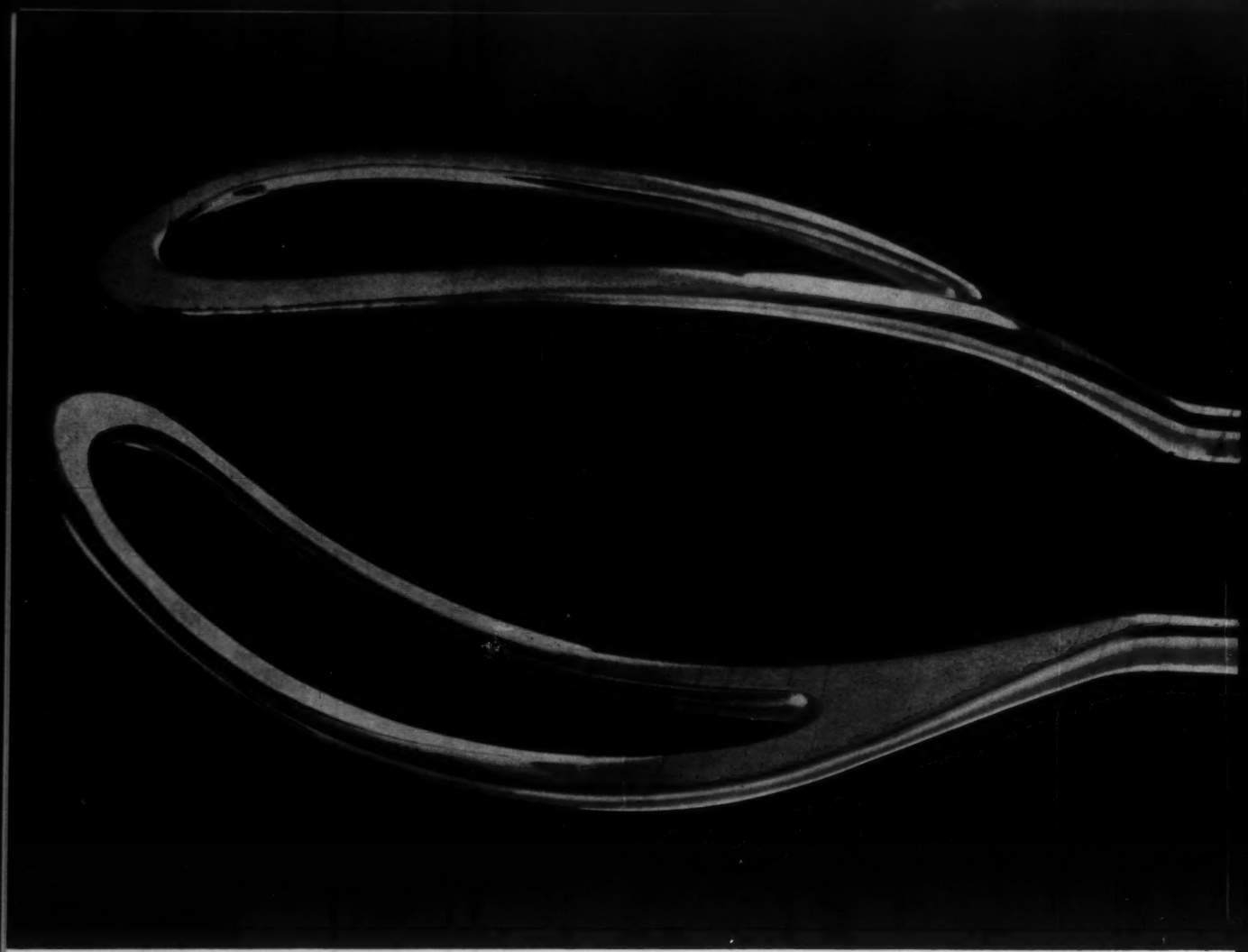
Address _____ State _____

City _____

ATLAS

POWER TRANSMISSION PRODUCTS

Circle 452 on Page 19



Corrosion Resistance It is an immutable law of Nature that all things seek their most stable state. Nitroglycerine craves opportunity to explode back into passive water and gas vapor. Radium glows silently as it decays into lead. Metals yearn to return to their oxides.

Corrosion is simply the return of a metal to its most stable form. It's an electrochemical process that is generally speeded up by the presence of salts, acids and moisture—in fact, at humidities below 50% there is virtually no atmospheric corrosion of steel. There are six common ways to minimize corrosion: select the right steel, apply protective coatings, install cathodic protection devices, set up periodic cleaning procedures, control the corrosive environment, and use *design* techniques which reduce the likelihood of corrosion.

We have a record of one case where a manufacturer installed expensive piping to transport gaseous chemicals—overlooking the fact that ordinary carbon steel pipe would do the job just as well *if it were insulated* to prevent condensation of the chemicals inside the pipe. Sometimes a vessel is designed with great care so that it will hold a corrosive liquid, only to have the vessel attacked from the *outside* because the support brackets harbored pockets of moisture. And there are cases on record of stress corrosion failure because it was not recognized that stress relieving was necessary after cold working the metal.

Actual service records or true-to-life corrosion tests are the safest ways to judge a grade of steel, and you can often avoid the expense and time-consuming nature of making your own tests if you check first with United States Steel.

A corrosion problem that is new to you may be familiar to us, and we may be able to supply you with information that will solve your particular problem promptly.

Another good reason for coming to United States Steel is this: no matter what kind of steel you need, you're sure to find it among the vast range of USS Steels for Design. The final selection, of course, should be made by a skilled metallurgist. Our technical staff is always available to consult with you about your problems. United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS, COR-TEN, TRI-TEN and "T-1" are registered trademarks

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS **United States Steel**

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

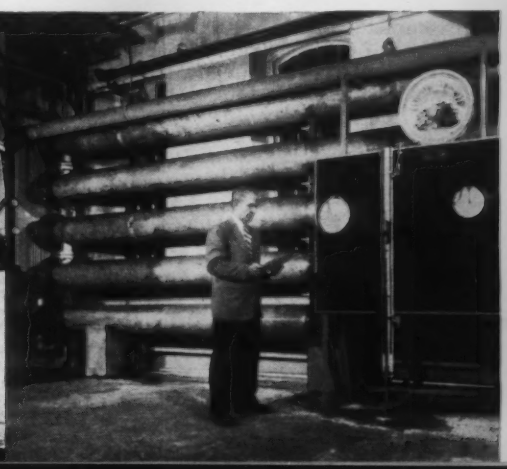
STEELS FOR DESIGN

Stainless Steel obstetrical forceps

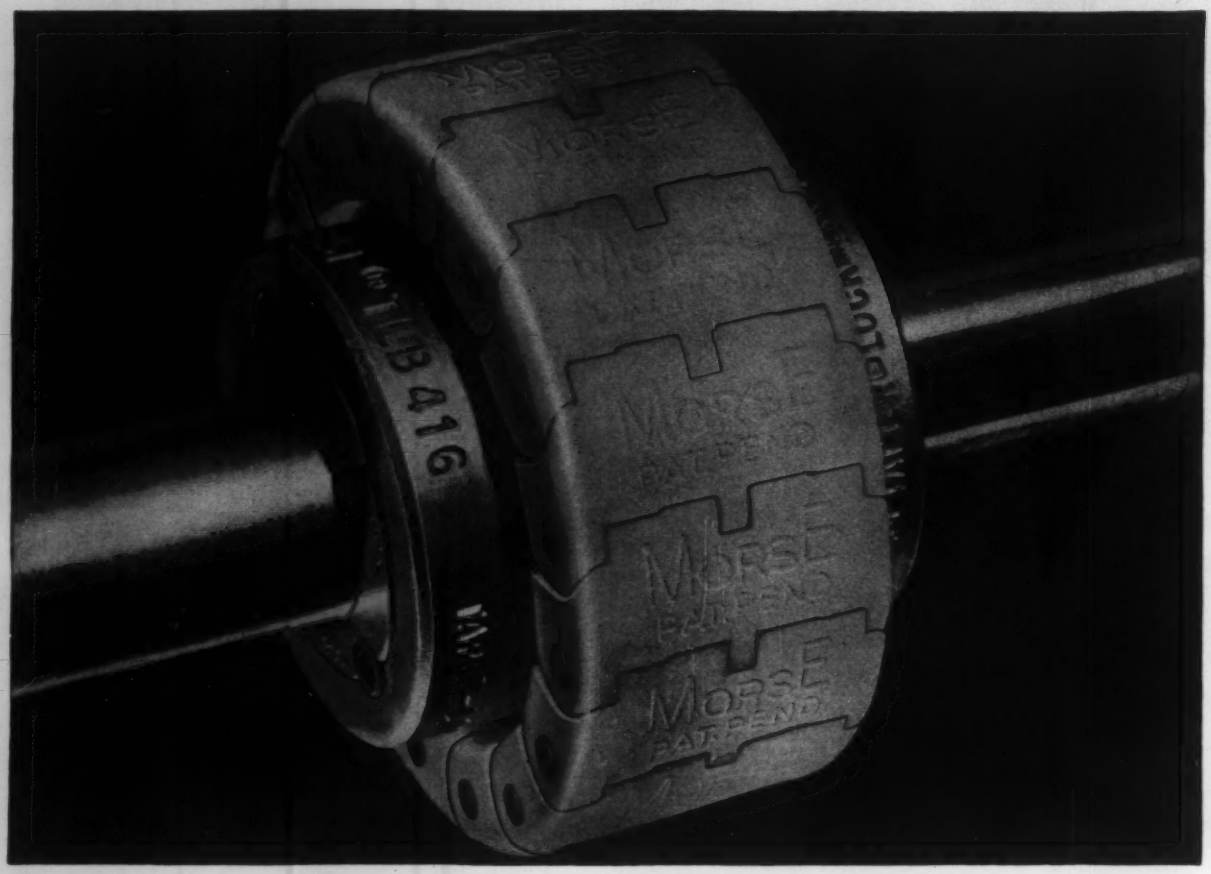
Lower Left—Problem: The City of Pittsburgh wanted a trouble-free hull on their new, all-steel fireboat. Solution: Paasch Marine Service built the hull with ¼" USS COR-TEN High-Strength Low-Alloy Steel. Payoff: A light, strong hull that has four to six times the atmospheric corrosion resistance of carbon steel plus superior paint adherence.

Lower Middle—Problem: Combat corrosion in the new Carquinez Strait Bridge by designing smooth, welded members eliminating details vulnerable to corrosion. Solution: USS "T-1" Constructional Alloy Steel and USS TRI-TEN High-Strength Low-Alloy Steel, both weldable and both having superior resistance to atmospheric corrosion. Payoff: The smooth, welded framework will assure much lower maintenance costs than the annual $70,000 needed to paint and maintain the old, riveted bridge. (And a bonus advantage: "T-1" Steel's high yield strength permitted strong, lightweight design, saving $800,000 in over-all cost.)

Lower Right—Problem: Design a preheating unit for a textile plant to handle hot water with a highly corrosive caustic soda content. Solution: 19,000 lineal feet of Type 304 Stainless Steel tubing inside the Stainless shells. Payoff: Ludell Manufacturing Company predicts that the unit will last indefinitely.



Now...from Morse Chain



New Nylon Couplings

Cost 20% less, need no lubrication, last indefinitely!

New Morse Nylon Flexible Couplings cost less to buy and maintain than steel couplings. They use economical, stock roller chain sprockets—need no protective cover. They last longer, too . . . operate without lubrication because friction and wear are negligible.

Order complete couplings—½" pitch links plus stock sprockets (plain, finished bore, or taper-lock)—or buy just the links and use your own sprockets. Morse Nylon Couplings, made of Du Pont "Zytel" resin, are ideal for loads from fractional to 40 h.p. and speeds from 500 to 5000 rpm. And they adjust to misalignment.

For facts on Nylon Couplings, or the other couplings in the most complete line ever offered, call your local Morse Distributor. He's listed in the Yellow Pages under "Power Transmission". Or write: MORSE CHAIN COMPANY, DEPT. 6-108, ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Illinois.

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE BW *Trademark

REMEMBER: Only Morse offers all four flexible couplings: Chain, Morflex and Radial, Morflex and Radial Driveshafts, and Nylon

Look alikes... until you look closely!

At first glance, all microfilm images look pretty much alike. But enlarge them in a film reader or in paper facsimile form, and you'll see the difference:

In the image produced under the Recordak Precision Engineering Drawing System, you'll note the pinpoint definition throughout . . . the remarkably uniform background.

New Recordak techniques and controls, perfected in three years of research and development, have made this possible—a 35mm negative that faithfully reproduces every detail of the original drawing. Duplicates, made from this negative, in film or paper form, are just as accurate.

As a result, drawings and negative and positive prints of all sizes—old or new, clean or soiled—can be photographed without loss of detail on 35mm film. Ends need for costly, larger size films.

Mounting each of these Recordak images on its own file Filmsort aperture card provides an active drawing file that takes 95% less space . . . saves reference and filing time. Extra reference copies—on film or paper—can be made at lowest cost.

And, of course, this Recordak System can be correlated with existing mechanized filing and duplicating systems for greater savings!

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"Recordak" is a trademark

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(Subsidiary of Eastman Kodak Company)

originator of modern microfilming
—now in its 31st year

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II-10

RECORDAK CORPORATION
415 Madison Avenue, New York 17, New York

Gentlemen: Send free booklet describing new Recordak Engineering Drawing System. No obligation whatsoever.

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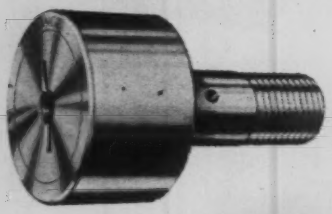
City_____ State_____

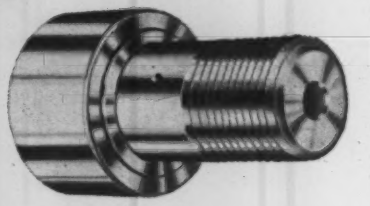
Circle 456 on Page 19

Why ORANGE bearings assure smooth, rugged service in Cam Action—Support—or Track Applications

ORANGE
CAM FOLLOWERS



TYPE S
Standard
Stud

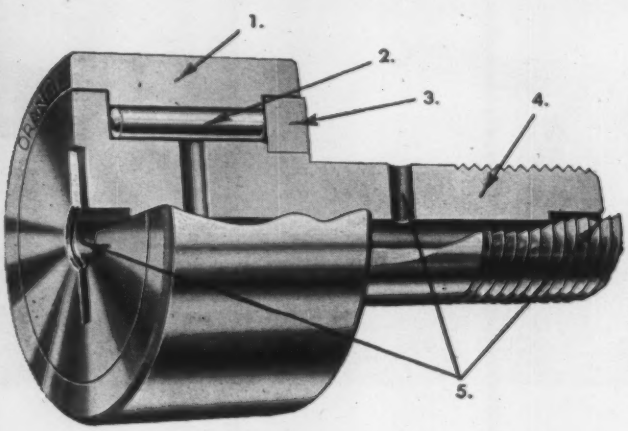


TYPE H
Heavy Duty
Stud

Heavy stud is available to afford greater shear resistance of the stem where severe operating conditions exist.

•

Orange Cam Followers are available in 22 standard sizes from ½" to 4" O.D. Chrome, Cadmium or Black Oxide finishes can be supplied. May be provided with seals where conditions require.



1. **Heavy-sectioned outer race** is made of thru-hardened, precision-ground, high quality bearing steel.

2. **Small diameter rolls** are made of high grade bearing steel, electronically gauged for uniformity of size.

3. **Case-hardened End Plate** permits the use of effective press fit for retention.

4. **Induction-hardened Stud** assures maximum hardness of the roller track, with core toughness to withstand high shock loads. Slotted end for convenient screw driver mounting.

5. **Selective Lubrication** for design flexibility. Drilled for drive type fitting. Closing plugs also furnished.

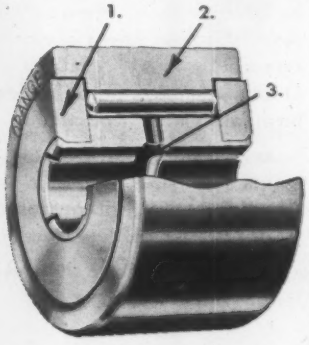
ORANGE
CAM YOKE ROLLERS

Ideal for yoke mounting in all types of machinery involving cam action, or control of machine elements requiring guide or support rollers. Available in 18 sizes from ¾" to 4" O.D. and can be furnished with Chrome, Cadmium or Black Oxide finishes.

1. **Staked End Plate.** The inner race is zone-hardened on the roller path for wear-resistance, while the ends remain more ductile to permit substantial staking for self-retention. Eliminates displacement caused by flimsy rings or insufficient deformation of thru-hardened inner races.

2. **Heavy outer race** thru-hardened to carry heavy loads.

3. **Ample lubrication** through center channel.

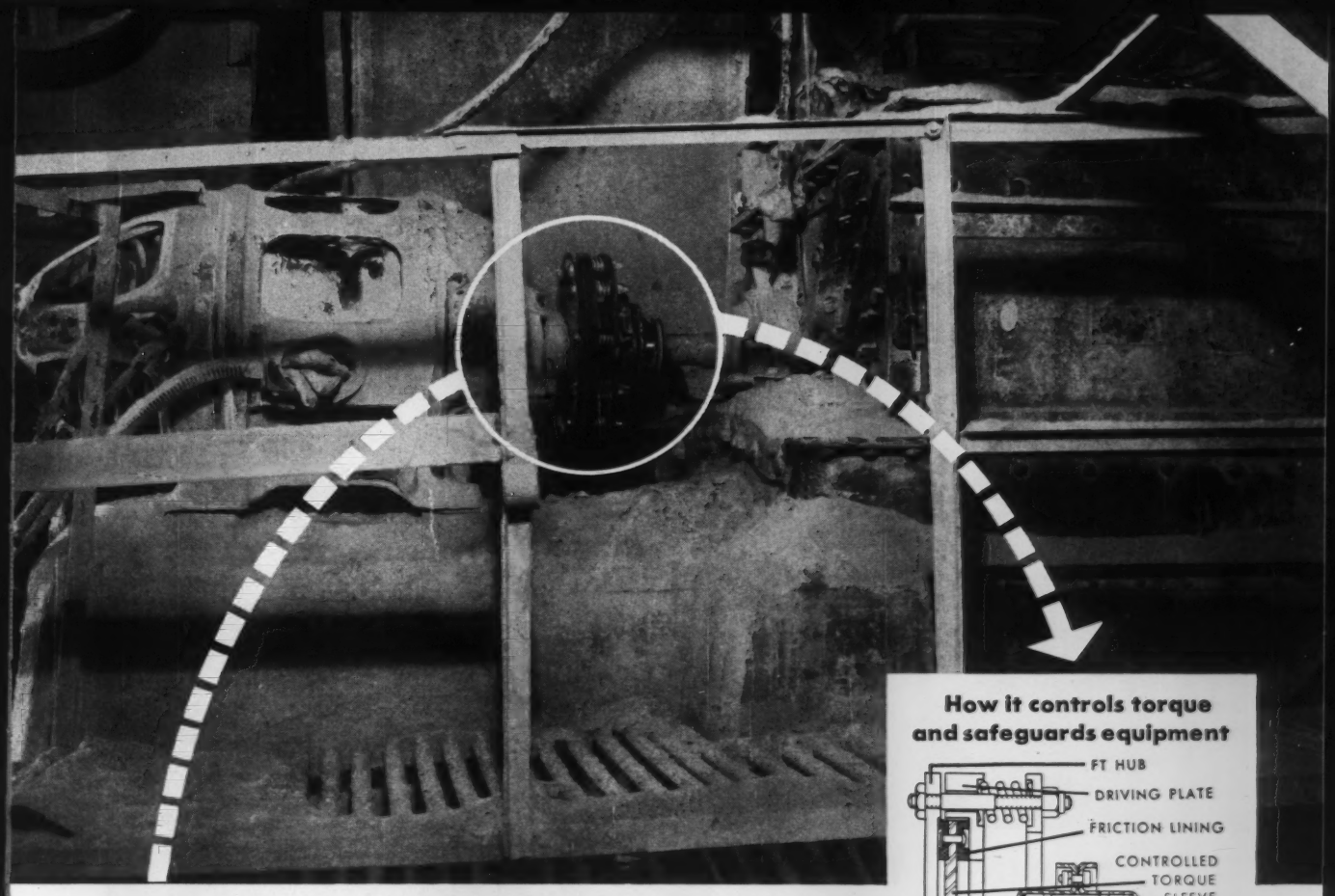


Write for 40-page Engineering Manual giving full details on Orange Cam Followers and Yoke Rollers, plus complete line of Orange Roller Bearings.

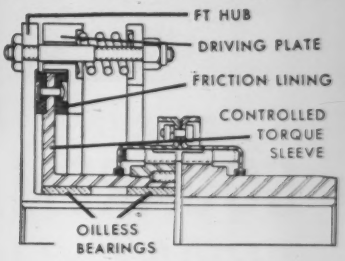
ORANGE
ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
556 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers



How it controls torque and safeguards equipment



Protect machines from overload damage with FALK Controlled Torque Couplings

The above picture shows a Falk Controlled Torque Coupling connecting a 150 hp motor to a hammermill. Formerly, when tramp iron got into the mill, it was necessary to rewind the motor at least twice a year. But, in the 2½ years after installing a Falk Controlled Torque Coupling, no motor repairs were required. *That is real saving!*

Wherever overload danger exists, a Falk Controlled Torque Coupling gives positive protection against machinery damage from excessive torque or jams. This unique coupling has an adjustable friction slip clutch which can be set at *any* predetermined torque limit. Thus, transmission of dangerous shocks is prevented...overloads are limited...shaft breakage is eliminated.

Another big advantage is that, when the cause of the overload is removed, the entire coupling will rotate and transmit power without resetting, and *without replacing parts or repairing the coupling*....And, the Controlled Torque Coupling incorporates the famous Falk Steelflex torsional resilience to smother ordinary shock and vibration, plus the ability to accommodate shaft misalignment....Consult your Falk Representative or Authorized Falk Distributor. **Ask for Bulletin 4100.**

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities.

Circle 458 on Page 19

Here (as in photo), the torque-control hub is shown mounted on driving shaft. From this hub, power is transmitted through friction lining to controlled torque sleeve. Load to be transmitted is determined by the (pre-set) pressure on friction lining. In case of overload, this hub still rotates until power is shut off—but the rest of the coupling and the driven machine will slow down or stop.

Motor Shut-off Control

By adding an automatic cut-out switch with V-belt connection to driven shaft, motor can be stopped immediately. With the standard hub mounted on driven shaft, the switch opens the electric circuit when speed of switch falls below predetermined value.

FALK

...a good name in industry

RIVETT SQUAREMASTER "100" CYLINDERS

Unfailing POWER for MILLIONS of cycles!

Here's sure power for unfailing cylinder operation. SQUAREMASTER 100's are the world's finest constructed cylinders—perform with 100% efficiency! 200 P.S.I. air to 500 P.S.I. oil. Available in 7 mountings with standard dimensions, in 10 bore diameters, internal and external threading. Special models and cover combinations. Priced competitively; prompt delivery; meet all J.I.C. requirements.

RIVETT, INCORPORATED

Dept. MD-10, Brighton 35, Boston, Mass.

*Initial High Coefficient of Static Friction

POWER-PACKED FEATURES PROTECTED BY POWER-GUARD CONSTRUCTION

1. Piston rod. Ground and polished alloy steel. Hard chrome-plated. **2.** Piston rod bearing. Replaceable cartridge-type. **3.** Piston packing adjusts automatically. V-block packing minimizes friction. **4.** Correctly stressed tie rods. **5.** Cushion bushings. Bronze, floating type. **6.** Ports rotated to any 90° position. **7.** Steel covers. Take minimum mounting space.

Send for catalog. Proof of SQUAREMASTER efficiency stated in these 20 pages. Write today.

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Member — National Fluid Power Association

Now you can get the famous advantages of ROCKWOOD Ball Valves—*IN STAINLESS STEEL*—

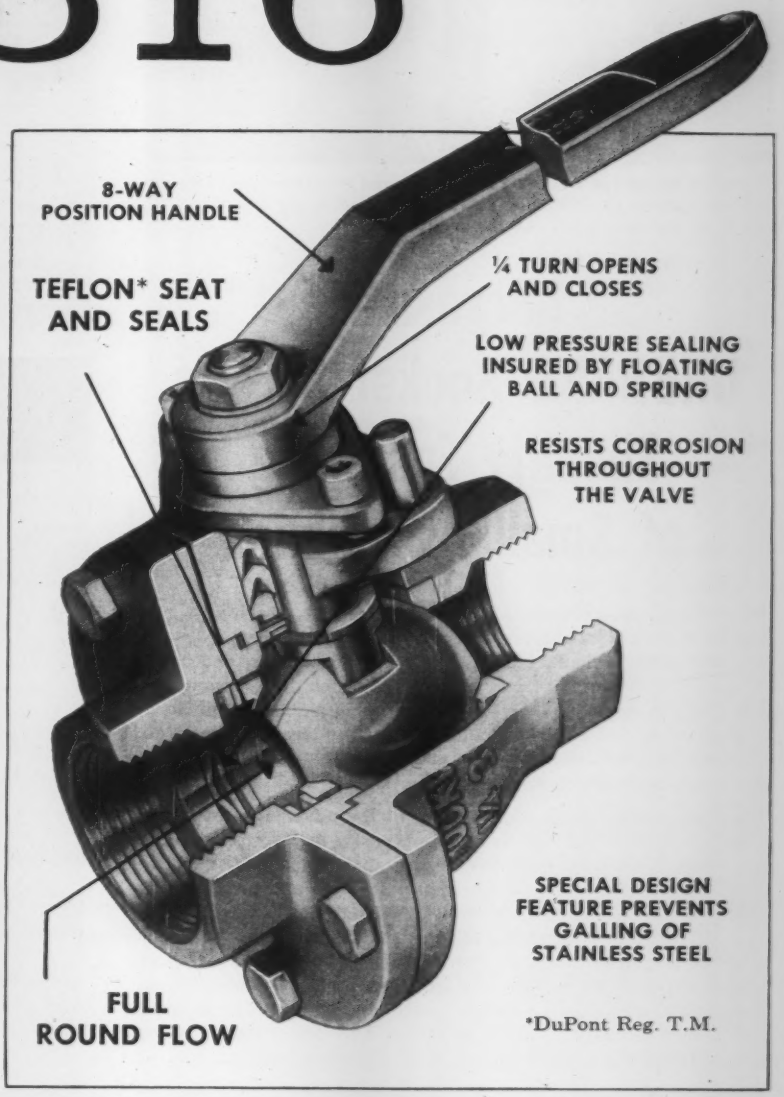
"316"

the

Rockwood's new "316" Ball Valve gives you positive sealing over a wide range of pressures. A simple design utilizing a Teflon ball seat and spring assures you of low pressure sealing (spring behind ball forces ball against the seat) and high pressure sealing (pressure supplements spring for pressure-tight seal). Friction loss and turbulence are also greatly reduced because of the "316's" straight full round flow passage. Features like these have made Rockwood the most dependable name in Ball Valves.

The new Rockwood "316" comes with various types of seats, remote air-operation of wanted sizes, ⅜" through 2" screwed ends, 3", 4", 6" and 8" flanged ends. 600 W.O.G. minus 100°F to 400°F. And it's just one of a complete line of Rockwood Valves and Unions.

Write for Rockwood's new catalog — the inside story of Rockwood Ball Valves is worth knowing. Tested and listed by Underwriters' Laboratories, Inc. Distributors in all principal industrial areas.


8-WAY POSITION HANDLE
TEFLON* SEAT AND SEALS
¼ TURN OPENS AND CLOSES
LOW PRESSURE SEALING INSURED BY FLOATING BALL AND SPRING
RESISTS CORROSION THROUGHOUT THE VALVE
SPECIAL DESIGN FEATURE PREVENTS GALLING OF STAINLESS STEEL
FULL ROUND FLOW

*DuPont Reg. T.M.

ROCKWOOD BALL VALVES

ROCKWOOD SPRINKLER COMPANY
1104 Harlow Street, Worcester 5, Massachusetts

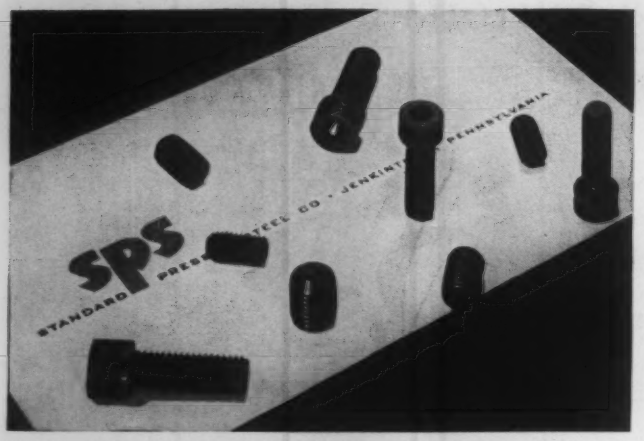
Send me your new Rockwood Full-Flow Ball Valves Catalog No. 57.

Name..... *Title*.....

Company.....

City..... *Zone*.... *State*.....

Circle 460 on Page 19



Standard microsize UNBRAKO socket cap and set screws, #0 through #3, are supplied by your authorized industrial distributor in heat-treated alloy or stainless steel. Available with Nylok* self-locking feature.

Microsize UNBRAKO Socket Screws Simplify Fastening of Small Assemblies

Microsize UNBRAKO socket cap and set screws save both time and money in the design and assembly of your small devices. Precision manufactured, available locally, they eliminate the cost and delay of designing or procuring special screws to fasten tiny components. Use them in computers, servomechanisms, instruments, miniaturized electrical and electronic equipment—countless small, intricate devices where reduction in weight and bulk is required without sacrificing strength or reliability.

These miniature socket screws have all the advantages of larger UNBRAKOS. Deep, accurate sockets for non-slip, high-torque wrenching. Radii in socket corners to eliminate sharp angles where cracks start. Fully formed threads for greater strength and precision fit. Controlled fillets under cap screw heads to prevent shearing. Careful heat treat for maximum tensile values without brittleness or decarburization. Because of these features, microsize UNBRAKO socket cap screws are as much as 80% stronger than ordinary miniature cap screws, and microsize UNBRAKO socket set screws can be torqued tighter than ordinary miniature set screws. This extra strength means greater reliability in the fastening of your small assemblies.

For more information, see your authorized SPS distributor. He carries microsize UNBRAKOS in both alloy steel and stainless in sizes #0, #1, #2 and #3. Or write us for Bulletin 2055 and samples. Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

We also manufacture precision titanium fasteners / write for free booklet

SPS Jenkintown • Pennsylvania

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co. • National Machine Products Co. • Nutt-Shel Co. • SPS Western • Standco Canada Ltd. • Unbrako Socket Screw Co., Ltd.

HEAT-TREATED ALLOY STEEL
Microsize UNBRAKO Socket Cap Screws
Class 3A Threads

Diameter		Threads per Inch NC	Threads per Inch NF	Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per 1000 in Pounds
#0	A .096		80	1/8		2.0	.21
	B .060		80	3/16		2.0	.22
	D .060		80	1/4		2.0	.26
	F .050		80	3/8		2.0	.33
#1	A .118		72	1/8		3.5	.31
	B .073		72	3/16		3.5	.36
	D .073		72	1/4		3.5	.42
	F .050		72	3/8		3.5	.53
#2	A .140	56		3/16	6.0		.54
	B .086	56		1/4	6.0		.61
	D .086	56		3/8	6.0		.76
	F 1/8	56		1/2	6.0		.91
#3	A .161	48		3/16	8.5		.77
	B .099	48		1/4	8.5		.87
	D .099	48		3/8	8.5		1.07
	F 3/16	48		1/2	8.5		1.27

HEAT-TREATED ALLOY STEEL
Microsize UNBRAKO Socket Set Screws
Class 3A Threads—Plain Cup Point

Diameter		Threads per Inch NC	Threads per Inch NF	Length	Recommended Installation Torque in Inch-Pounds NC	Recommended Installation Torque in Inch-Pounds NF	Weight per 1000 in Pounds
#0			80	1/16		.5	.03
			80	3/32		.5	.04
	D .060		80	1/8		.5	.05
	F .028		80	5/32		.5	.06
			80	3/16		.5	.08
			80	1/4		.5	.11
#1			72	1/16		1.5	.04
			72	3/32		1.5	.06
	D .073		72	1/8		1.5	.08
	F .035		72	5/32		1.5	.11
			72	3/16		1.5	.13
			72	1/4		1.5	.19
#2		56		1/16	1.5		.05
		56		3/32	1.5		.07
	D .086	56		1/8	1.5		.107
	F .035	56		5/32	1.5		.15
		56		3/16	1.5		.19
		56		1/4	1.5		.273
#3		48		3/32	5.0		.10
	D .099	48		1/8	5.0		.135
	F .050	48		5/32	5.0		.18
		48		3/16	5.0		.235
		48		1/4	5.0		.32

HIGH RELIABILITY

SPS research is continually developing fasteners with higher and higher standards of predictable performance. By installing SPS high-reliability fasteners in your assemblies, you increase your overall product reliability.

For more information on the full meaning of reliability, write for a copy of the new SPS booklet "High Reliability."

Circle 461 on Page 19

smart design engineers leave their CLUTCH and BRAKE problems to us...

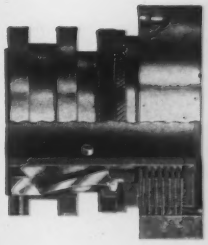
They do it every day... because they save time, engineering costs and design headaches by using our PROVEN, standardized clutch and brake units.

Shown here are the basic types . . . including the Industry's most successful ELECTRIC Clutches and Brakes . . . available from stock in a full range of sizes, and ready to go to work in your equipment *with assured performance.*

Equally valuable is the advice and practical help on special problems you can always get by calling our experienced engineering department. It usually pays to "TALK MAXITORQ" first.

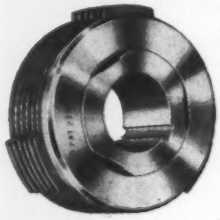
electric clutches and brakes

PROVED design, Floating Disc action is fast and positive, with no heating or drag in neutral. Compact, simple, with few moving parts. For WET or DRY operation: Electrical operating unit DOES NOT REVOLVE; no brushes or slip rings. Uses easily replaced standard Disc-Pac. Requires no adjustment. Wide range of standard sizes, single and double types. All sizes rated 80 watts, operate on 110 V. A.C., rectified to 90 V. D.C. Other voltages on special order.



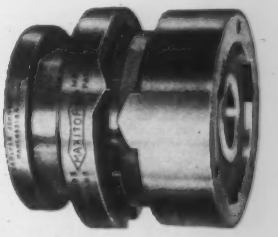
standard floating disc clutches and brakes

MAXITORQ offers you PROVED performance in every type of service with the following important advantages: compact design with few and sturdy parts . . . floating neutral with no heating or drag . . . positive engagement or release with light pressure . . . manual assembly and adjustment . . . full power transmission . . . full range of sizes and types . . . supplied as complete, easily installed units.



LET'S TALK

Maxitorq



disc-pac

The "heart" of the SERVICE-PROVED Maxitorq Floating Disc Clutch in a compact, assembled unit for those who wish to design and build their own clutch mechanisms. Supplied as complete units ready for use in 8 diameters 2" to 8", up to 800 ft. lbs. capacity. Also useful as a multiple disc brake or torque limiting device.

overload release clutches

One of the simplest and most efficient methods of providing a DEPENDABLE and easily adjusted overload release on machines requiring this safety feature in addition to a clutch. Incorporate all the advantages of MAXITORQ Floating Disc design plus automatic and complete release upon overload. Proved in service. Available in a wide range of sizes.

Write for complete data and specifications on any or all of the above. If you have a problem involving clutch applications, consult us. A letter or phone call will receive prompt attention. Dept. MD-10.

THE CARLYLE JOHNSON MACHINE COMPANY, MANCHESTER, CONN.

Let's talk MAXITORQ

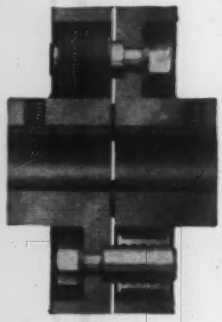
SCJ58

Circle 462 on Page 19

WHEN YOU SELECT AJAX® FLEXIBLE COUPLINGS

YOUR CHOICE IS BACKED BY 38 YEARS OF COUPLING KNOW HOW

AJAX BRONZE BUSHED, RUBBER CUSHIONED COUPLINGS



AJAX bronze bushed, rubber cushioned couplings provide positive resilient transmission of power between driving and driven units. Steel studs are hardened and ground, and bronze bushings are self-lubricating. Rubber bushings provide flexibility without creating vibration, backlash, chatter, strain on bearings, and other detrimental factors.

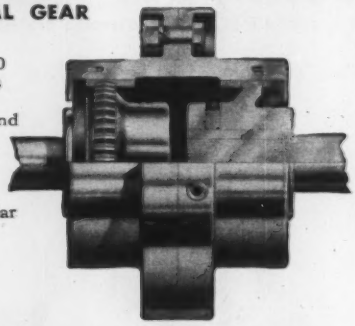
Couplings available with forged steel, cast semi-steel, and non-ferrous flanges. Write for Catalog 55-B giving complete working data.

AJAX TYPE 400 NORMAL DUTY COUPLINGS

Particularly suited to connect motors directly to pumps, fans, generators, speed reducers, mixers, light duty compressors, hoists, etc. A quality coupling at lower prices than any other cast iron or steel flexible coupling. Write for catalog covering sizes from 5/8" to 2 3/4" maximum bore.

Write for Catalog 67.

AJAX DIHEDRAL GEAR COUPLINGS

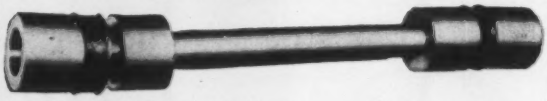


AJAX Series D-100 Dihedral Couplings handle shaft misalignment far beyond the capacity of conventional flexible couplings. The 7 degree angular and/or offset capacity of stock sizes is ample for most installations. Teeth can be cut for greater degrees of misalignment on special order. Positive seals keep lubrication in and dirt out. Series D-100 Couplings have all teeth hardened. They are available in double engagement, floating shaft and mill motor types in a wide range of capacities. Write for catalog 62.

AJAX 3-D DIHEDRAL COUPLINGS

AJAX 3-D Dihedral Couplings provide angular and offset capacity up to a total of 3 degrees at competitive prices. They cure breakdown troubles where there are failures due to weaving, foundation problems, and twisting strains. Write for catalog 65.

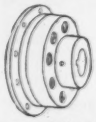
AJAX FLOATING SHAFT AND SPINDLE COUPLINGS



AJAX Dihedral Spindle Couplings are increasing output, improving product quality, and reducing maintenance costs of ferrous and non-ferrous rolling mills. Write for Catalog 64.

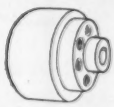
AJAX COUPLINGS FOR SPECIAL APPLICATIONS

AJAX design permits many special adaptations for serving dual purposes or where space limitations or other conditions are encountered. Write giving your individual requirements.



Ajax Type BO Bolt-On Coupling

Ajax Type SP Shear Pin Coupling



Ajax Type BD Brake Drum Coupling

Floating Shaft, Quick Disconnect, Mill Motor and other types also available.

AJAX FLEXIBLE COUPLING CO. INC. • WESTFIELD, N. Y.

Also Manufacturers of Vibrating Conveyors, Screens, and Packers

Incorporated 1920 *Representatives in Principal Cities*

CUT COSTS WITH

Crucible fatigue-resistant springs—

"MADE STRONGER TO LAST LONGER"

These Crucible coil springs offer far greater fatigue resistance than ordinary springs. They therefore cut replacement costs substantially.

Because the springs are stronger, they can carry greater loads, too.

The reason why these springs have higher strength and last longer is due to the fact that they're *shot peened*—

Shot peening imposes a compressive stress on the surface that offsets stresses set up in service. It also conditions the surface. And it eliminates minute stress concentration points which could lead to premature failure in a conventional spring.

Shot peening, together with Crucible metallurgical skill (from ore to finished spring), ensures springs that withstand high stresses longer. Hot-wound, *fatigue-resistant* springs are available in a wide variety of sizes, analyses and treatments to meet your compression, tension, and torsion spring requirements.

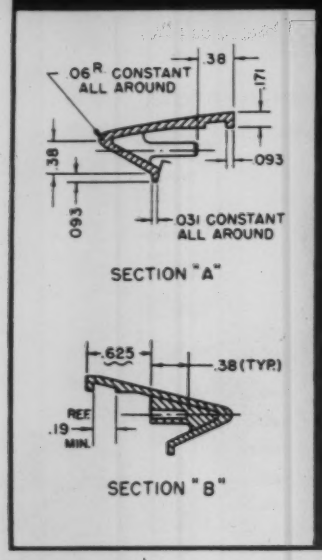
For more information on cutting costs with springs, send for a free copy of Crucible's "Coil Spring Design" handbook. Or have a Crucible spring specialist call on you. Write: *Spring Division, Crucible Steel Company of America, McCandless Avenue, Pittsburgh 1, Pa.*

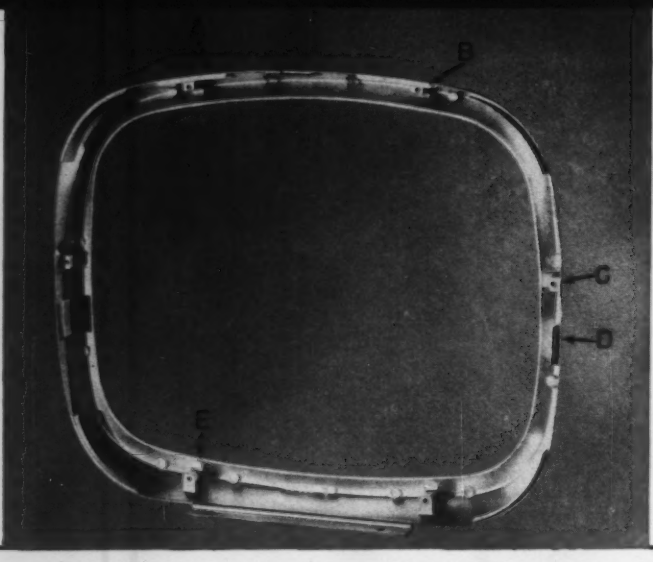
CRUCIBLE HEAVY-DUTY COIL SPRINGS

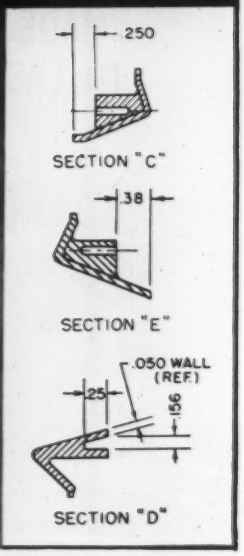
Circle 464 on Page 19

FOR *Light Weight with Strength*

ZINC DIE CASTINGS ARE BEST







RCA Victor proves that the lightest metals do not always produce the lightest weight parts. This RCA Victor Portable Television Receiver is built with a ZINC Die Cast bezel and screen mask that weighs less than one pound, yet provides the strength and rigidity necessary for a structural part of the entire housing.

The sharply edged brow, thin wall sections, streamlined shape, compound curves and built-in conveniences for easy assembly are possible only by the die casting process. Die cast of ZINC, this bezel meets every requirement for the modern styling of the RCA Victor Flight-Line Series of receivers.

HORSE HEAD SPECIAL ZINC AND ZAMAK ARE PRODUCED BY

THE NEW JERSEY ZINC COMPANY

DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY

160 Front Street · New York 38, N. Y.

HORSE HEAD PRODUCTS

DESIGN
October 30, 1958

Voluntary Unionism?

NEXT week voters in six states will decide whether to join eighteen other states in approving so-called Right-to-Work amendments. The issue has implications for engineers in their job relationships.

As the law (Taft-Hartley) now stands, a worker cannot be fired by his employer for union activity. Nor can a union require the employer to fire him if he is expelled from the union for any reason *except nonpayment of dues*. The amendments reiterate these basic safeguards for the individual worker, but also go a step further. In effect, they would eliminate the four italicized words, thus outlawing the union shop.

That's the crux of the controversy, after all the blasts, counterblasts, threats, and emotions are swept away. Strong unions are afraid that, under voluntary unionism, they will be weakened by mass desertions. They fear that workers would be willing to accept a "free ride" to the benefits of collective bargaining without contributing toward their attainment.

Unlike many labor unions, engineering unions mostly have operated in "open shops." Thus engineering unions are now in the same position that all unions may find themselves one day if the proposed new amendments are generally adopted. Would that be a serious handicap to union effectiveness? Alternatively, would the rejection or repeal of such provisions pave the way for compulsory unionism even in engineering departments?

It seems fair to ask: Shouldn't a mature, honest, well-run union be able to count on the support of an adequate majority of employees involved? Wouldn't a union be stronger, and its members be more active and enthusiastic, if member support had to be earned rather than commandeered?

The issue seems to boil down to this: A union may have difficulty convincing its members that it is giving them their money's worth. How important is it to insure the security of such a union?

Colin Carmichael

EDITOR

LOOKING FOR NEW-

Thoroughness is the keynote . . . the more places searched, the greater your chances of success

SEARCHING for new-product ideas is the most glamorous and enjoyable portion of the product developer's work; but it takes a great deal of ability and personal finesse to do the job well. Finding a good new-product idea is the cornerstone of successful product development. Without good ideas to develop, there can be no successful new products.

If this phase of the product developer's activity is properly approached, and if he uses enough native ability, he can easily find more ideas than he can possibly investigate. In fact, one person can keep 100 or more people busy investigating and developing prospective new products; the number depends on his skill and ability, how hard he works, and how wide a product range he is permitted to explore. Therefore, other skills, knowledge, and abilities must be used to identify and discard the poor or marginal ideas.

No one man, not even a new-product development specialist, can afford to depend on his own ideas. The major problem is how to find the ideas created by others. Some of these ideas may be recorded; however, many of them must be mined from the thoughts of associates and contacts. This task calls for an acute awareness and sensitivity that are responsive to the slightest hint or suggestion of a potential new-product idea. Individuals performing this task should have both creative ability and the ability to associate ideas and facts in new relations.

Sources of New-Product Ideas: The greater the number of sources scanned, the better the chances are of successfully finding a good idea. Idea creation, being a most difficult process, does not occur often and usually only under certain conditions. It is therefore wise to utilize every source available, such as those given in the Idea-Source Checklist.

The art of asking questions in combination with skill in conversation—plus other attributes, of course —can easily unlock many of the storehouses of ideas, particularly the unrecorded ones. This is especially true if the searcher obtains a few "skeleton" keys. These keys consist of a suitable approach and appropriate questions which together will help materially in triggering the required thought actions in the contact. Sometimes the actions are delayed and a second, third, or even more tries are necessary before the idea is found or created.

▶ Where Ideas Start

Direct Creation of Ideas: The first of the three ways that new-product ideas are born is by direct creation of an idea by an individual. This is the most difficult since only one man is involved and no assistance by others is possible. It obviously requires (except in accidental cases) a high degree of creative ability, plus the ability to associate new ideas with old facts in new relations. It is a process for which a "how-to-do-it" manual cannot be written. The person who can directly create good ideas will usually have an unquenchable thirst for knowledge and will therefore read widely and vicariously. He also will probably have a high degree of intelligence plus the ability to mentally "keep both feet on the ground" and exercise sound judgment and common sense.

Requirements for successful new-product idea creation are so stringent that the proper conditions are only rarely encountered. Hence, this is not the usual method of idea creation.

An example of direct idea creation and of how famous inventions often become ours through accident is the invention of safety glass. Dr. Edourd Benedictus, in France, one day dropped a glass chemical flask, the inside surface of which had become coated with a thin film of plastic because Benedictus neglected to clean the container. When it hit the floor, the glass broke into many pieces, but the plastic film held the pieces together, rather than allowing them to fly over the laboratory as usual. He observed the phenomena, but didn't think any more about it at the time.

PRODUCT IDEAS?

By **DELMAR W. KARGER**
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Several days later, he saw two automobiles collide; one of the occupants was seriously injured by flying glass. He associated this occurrence with his previous accident with the flask. These phenomena and facts were then associated in a new relationship. The result was today's safety glass.

Synthesizing the Idea: Two or more discrete ideas can be combined to yield more ideas. It is a very productive chain-reaction thinking process when applied to finding new-product ideas.

In most cases, an idea is not fully spelled out in usable form. More commonly, ideas are encountered which steer thinking in directions that result in new-product ideas. Idea sources will usually prove barren and the ideas encountered will be wasted unless explored by an imaginative mind that can combine two or more ideas into still others.

Catalyzing Ideas: The new-product developer can act as a catalyst to accelerate idea generation. This is an integral and important part of the responsibilities associated with new-product development. In fact, the majority of the ideas found or explored will result from such action.

Ideas produced through catalysis involve synthesis or will appear to be direct creation except for the presence of the extra person—the catalyst. The process is hard to define or describe since each situation is different—different people, personalities, and settings. However, the catalyst, of necessity, must be one who is able to carry the larger share of the conversation He must contribute to its contents and inspire the other participants to exercise their mentality to a high degree. Enthusiasm is required since it helps inspire the others. Contrarywise, an uninterested, unenthusiastic person, will not act as a positive catalyst—but as a negative one. He will slow down idea generation.

Basic Approach: Any individual, in the plant or out of it, and regardless of whether he is a manager, professional associate, engineer, foreman, worker,

LOOKING FOR IDEAS?

This is the way it's done:

1. **Know where to look.**
2. **Learn to ask questions.**
3. **Look for idea creators.**
4. **Try to combine ideas.**
5. **Encourage people to think.**
6. **Convince them of your need.**
7. **Show how they can help.**
8. **Talk to everybody.**
9. **Probe their desires.**
10. **Find out what they would like.**
11. **Study new developments.**
12. **Read all idea sources.**
13. **Consider licensing patents.**
14. **Try marketing firms.**
15. **Contact research institutes.**
16. **Study your own purchases.**
17. **Keep looking.**

housewife, friend, or chance acquaintance, should be approached by emphasizing in the opening conversation the need for two things: 1. Their support. 2. The likelihood that they can produce usable ideas. Their support is needed since no one person can have all the necessary ideas, especially all the good ones. All that is necessary to remind oneself of this fact is to look at the sources of some of the world's great inventions. Almon B. Stroger, a mortician, mad at an operator for her poor handling of his telephone calls, invented the first dial telephone. Murray Spangler, a janitor suffering from asthma caused by the dust raised by his broom, invented the vacuum cleaner. George Westinghouse, reading a magazine article about the use of compressed air in a tunnel project, invented the air brake for the railroad train. A prisoner in jail was responsible for the invention of the toothbrush. Moral: Don't overlook anyone!

Their work is of the kind which cannot help but generate ideas and suggestions. Many will disclaim this and it will be necessary to bring them "to light" by adroit questioning. However, they still feel complimented by the statement that logically their work should help create ideas—all of us like to feel that we are creative. In fact, everyone is creative to some extent and certainly his or her occupation will not prevent idea creation.

Approaching Company Engineers: Most of the product ideas will be obtained from engineers—all types and kinds of engineers, regardless of their organizational location, not just research engineers or new-product development engineers.

Since engineering managers, supervisors, and project engineers have the broadest contacts and generally are more mature and well-trained, they should be approached first. Typical approaches are:

1. A direct and unrestricted request for new-product suggestions.
2. A request to describe any unusual features of equipment being designed, followed up with questions as to why or how this portion of the project could be converted into a new product.
3. A direct question as to which components, subsystems, or mechanisms developed in the past, as well as present work, were unusual.
4. As a last resort (and this almost always ferrets out items worthy of discussion), ask them to describe the equipment they are now engineering. Here the product developer's skill in posing the proper follow-up questions is of paramount importance—in other words, he acts as a catalyst.

The same approach should be used for other engineering personnel, except that the questions need to be slightly altered, depending on the specific situation. If they are working for another company, account must be taken of the fact that their primary loyalty and responsibility is committed to another firm.

Approaching Other Plant Personnel: This group should be considered as comprising everyone from the president to the janitor. First, the suggestions for engineers should be used where at all appropriate. These can and should be supplemented by others, such as:

1. What can they see as a real need (as a consumer if this applies) for your industry to develop and offer for sale?
2. What new equipment, mechanism, or gadget would they like to see developed to help them in their work or to help in someone else's job?
3. What safety device do they see a need for?
4. What have they heard others say was needed as a new product on the market?
5. What operation (or series of operations) on their job or someone else's job seems unnecessarily difficult? This can often lead into a new-product idea—even though it is foreign to your industry or the desired category of products.
6. What would help them reduce the cost of their task or responsibility? Some people need the dollar concept brought up to trigger their thoughts.
7. What task or operation have their friends complained or talked about as being difficult or expensive?
8. What item of equipment is not performing properly and why? This may lead to a new or improved product.

Variations of these and other questions could be listed, but these should suffice to show what can and should generally be done to bring out needed ideas.

Nonplant Personnel: The same approach and practically all of the questions work equally well for this category of persons. The principal change is to recognize that nonplant personnel may have an actual restriction existing on the topics or items about which they can freely comment. This is especially true for government personnel or people working on military projects or producing products going to the armed services.

▶ Printed Ideas

There are many sources for ideas in print. The Production Assistance Division of the Small Business Administration publishes a monthly listing of available new products under the title of *Products List Circular*. Most of the listed items were privately developed and can either be purchased outright or licenses to manufacture and sell are procurable.

Another source for new-product ideas is the *Patent Abstracts* of government-owned inventions available for license from the U. S. government. Licenses for producing and selling these inventions can be obtained from the government agency having cognizance of the patent. At the present time, there are seven books covering different classifications of inventions, plus eight books of supplementary patents; the total number of available patents is 6819. The books are available from the Office of Technical Service of the Department of Commerce.

Other government publications which contain ideas that may be of help in new technical-product

Idea-Source Checklist

Here are the places to look:

Unrecorded Sources

- ☐ Plant personnel
- ☐ Professional associates
- ☐ Friends
- ☐ Sales representatives
- ☐ Advertising agency personnel
- ☐ Venders
- ☐ Government personnel
- ☐ Equipment manufacturers
- ☐ Customers

Recorded Sources

- ☐ Lists of available products
- ☐ Licenses available from the government
- ☐ Licenses available from industry
- ☐ Professional marketing firms
- ☐ Articles in professional and trade journals
- ☐ New-product announcements
- ☐ "I wish I could buy_____" columns

Miscellaneous Sources

- ☐ Professional R & D companies
- ☐ Companies interested in area commercial development
- ☐ City, county, and state industrial development commissions
- ☐ Trade associations
- ☐ Commercial bankers
- ☐ Organizations that search patent records
- ☐ Company acquisition
- ☐ Internal make-buy decisions

development are *U. S. Government Research Reports* (actually a catalog of these reports) and *Technical Reports Newsletter* (a digest of research reports published monthly).

Technical and trade journals, both domestic and foreign, often carry advertising in which a new product is offered for sale. Some of these inventions can be purchased outright while others are limited to a license to manufacture and sell.

Licenses: Many of the major industrial firms have an internal patent and/or licensing department, or have an outside firm set up to handle these functions. If interested in a particular category of products, or a particular product, an inquiry to the appropriate company may ferret out patents under which licenses are available.

Just because a large company holds a patent on a process or other item and fails to actively engage in marketing it does not necessarily mean it could not be a successful product. Often such ideas are not exploited because the company uses the process or item on an internal basis, or the product is foreign to existing product lines. Sometimes the company is primarily interested in supplying the basic material needed in making end items. An example of this latter situation would be Fansteel Metallurgical Corp., who were and are interested in expanding the use of tantalum. Since electrolytic capacitor manufacturers were slow in exploiting the properties of this metal, Fansteel started producing tantalum electrolytic capacitors. At the same time, Fansteel is interested in having other firms join in producing such capacitors.

The principal difficulty encountered in trying to use this approach is that the company may insist that the prospective client disclose rather specifically what product or type of product he is interested in and why. Also, unless you are affiliated with a well-known firm, they will want some reasonable proof or assurance that your company really is capable of, and intends to, manufacture and sell any product that shows good potential and falls into the desired product line.

Professional Marketing Firms: Legitimate marketing firms offer a real service to inventors and prospective purchasers and save both interested parties time and money. However, it would appear that some of these firms are more interested in proving to the inventor that they are working for him by sending out letters and notices to companies—even though the items offered are not remotely related to existing product lines in the recipient companies. In spite of this, one good new product certainly justifies screening many ideas that cannot be used. Some of these firms also offer a direct service to industry in searching for and screening prospective inventions for new-product ideas.

Professional and Trade-Journal Articles: Publications can be the source of a new-product idea, even a direct one. While an article may have been written by an engineer of another company it may still

be a good lead because: 1. Your engineers may develop a better idea from it. 2. It may be good enough to permit two firms to manufacture and sell. 3. The originating company may have no interest in producing it commercially. The latter situation often occurs in a large firm specializing in making complicated end items where the described development is merely a component, subsystem or process development. Many such developments are not patentable and can be produced and sold without paying for the idea. Such articles can also often be the indirect source of an idea through synthesis with other related ideas as previously mentioned.

In a similar manner, reviewing new-product announcements in technical and trade journals often will trigger an idea, yielding a new product or an improved product. Anyone interested in new-product development should continuously screen such announcements, not only for the reasons given, but also because it is of vital necessity to keep abreast of developments and/or new products being offered by competitors or potential competitors.

Other Idea Sources

Research Institutes: Many nationally known firms, laboratories, or institutes will take on the job of finding and/or developing new products. There are two basic types of these firms: 1. Independent institutes set up to only do research and which have no other purpose or affiliation. 2. Institutes affiliated with colleges or universities which usually have other objectives to a minor degree, such as promoting the university or providing part-time employment to professors and students. These may have a less-commercial orientation which could be good or bad, depending upon the project involved. Almost every college or university that offers a technical curriculum will accept some outside research or consultant jobs.

Examples of some independent institutions in the United States are:

Midwest Research Institute, Kansas City, Mo.
Southern Research Institute, Birmingham, Ala.
Battelle Memorial Institute, Columbus, Ohio.
Mellon Institute, Pittsburgh, Pa.
Armour Research Foundation, Chicago, Ill.
Southwest Research Institute, San Antonio, Tex.
Franklin Institute, Philadelphia, Pa.

Since the work they do is on a contract basis, it is advantageous to define the work to be done as precisely as possible. The least that should be done is to specify the product category. This latter approach will incur maximum expense, yet it can be well worth the cost. The reasons for going to such firms for service are numerous. Some of the reasons are:

1. The firm's engineering and/or research staff is loaded and cannot accept the additional work without expansion.
2. Time is not available to expand the staff to accomplish the desired work.
3. Desired product or product category is not well suited to existing engineering skills in the company.
4. Research and/or development facilities needed necessitate a large and undesirable capital expenditure.
5. Development firm has the required very specialized personnel and/or facilities.
6. There exists a partially developed idea that appears to have great potential, but which the firm's own designers have been unable to make work satisfactorily, or unable to production engineer it so that it can be produced at competitive cost.
7. It is desired to see what can result from scientists who are not as rigidly controlled as those within your own company.

Firms Promoting Industrial Growth: Typical firms and associations interested in promoting general or specific industrial growth often have product suggestions to offer. These are not necessarily new, but they usually have some associated positive reasons why it would be a successful product. However, this type of assistance most often applies to the consumer-product category, rather than to technical products.

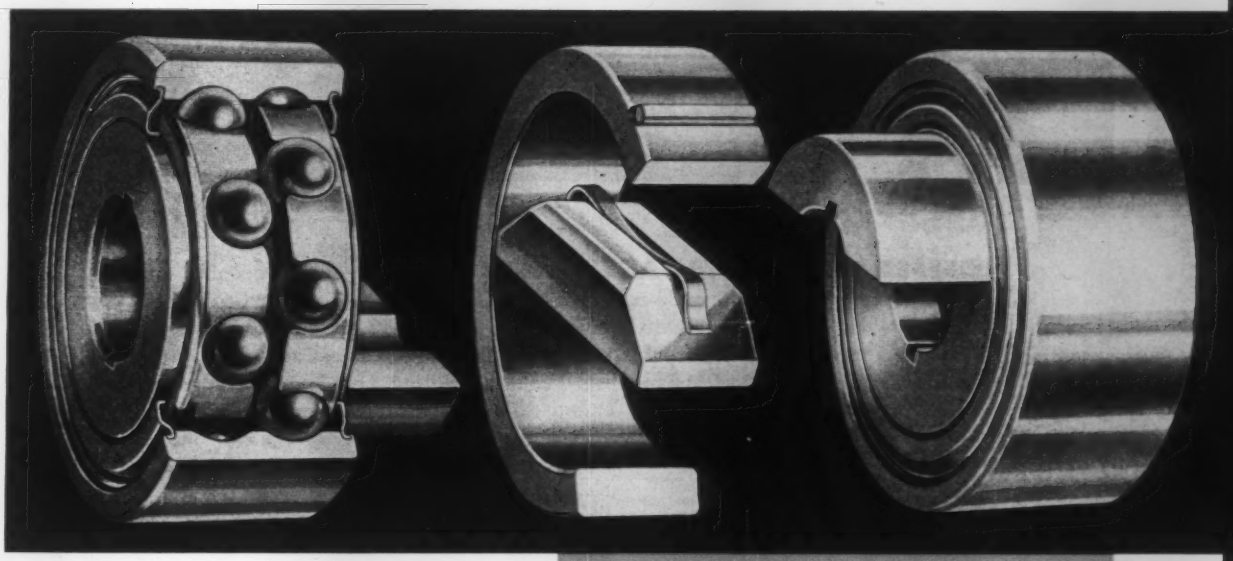
Company Acquisition: In many respects, there is little difference in the end results obtained by finding the new-product idea and developing it internally from acquiring the new product through company acquisition. The advantages in company acquisition are great since company growth is achieved in the shortest possible time. Not only does the purchaser obtain new products, but also facilities to produce, personnel to manage and operate, and marketing and distribution channels.

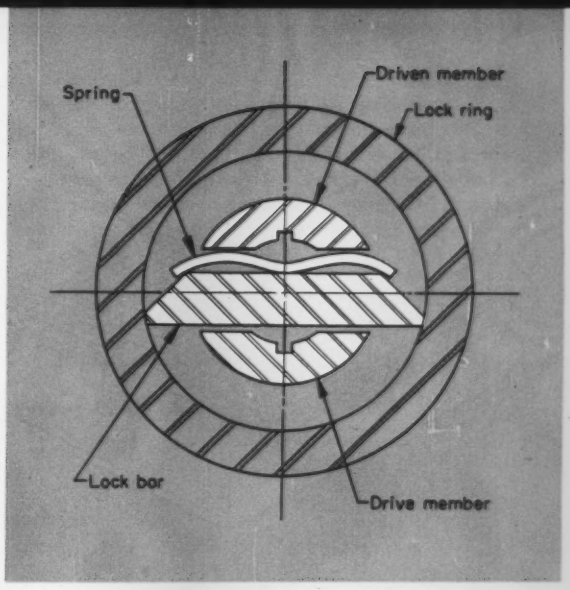
Internal Make-Buy Decisions: Almost every company continuously screens its parts and materials, on either a formal or an informal basis, to determine whether to make the item or to purchase it. Those interested in new-product development would be wise to regularly review the results of these analyses. It may be possible to find a new salable product and at the same time, gain a cost reduction for an existing product. While such new products will usually involve competing with one or more existing manufacturers, there is also the advantage of having a captive market—one's own company.

They Say . . .

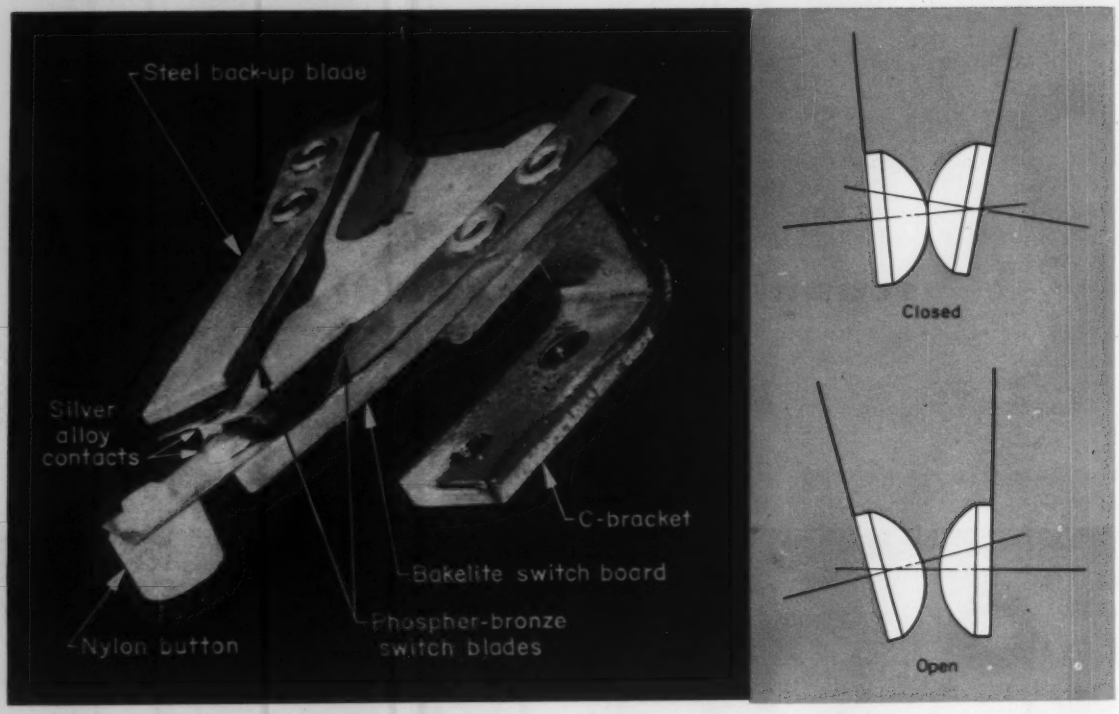
"The creative man is not bound by preconceived ideas. Consequently, some of the results of his work may appear too radical for acceptance. These should not be brushed aside without careful and objective evaluation, however, for history reveals that yesterday's heresy frequently becomes tomorrow's orthodoxy."—JOHN T. RETTALIATA, *president, Illinois Institute of Technology.*

scanning the field for *ideas*

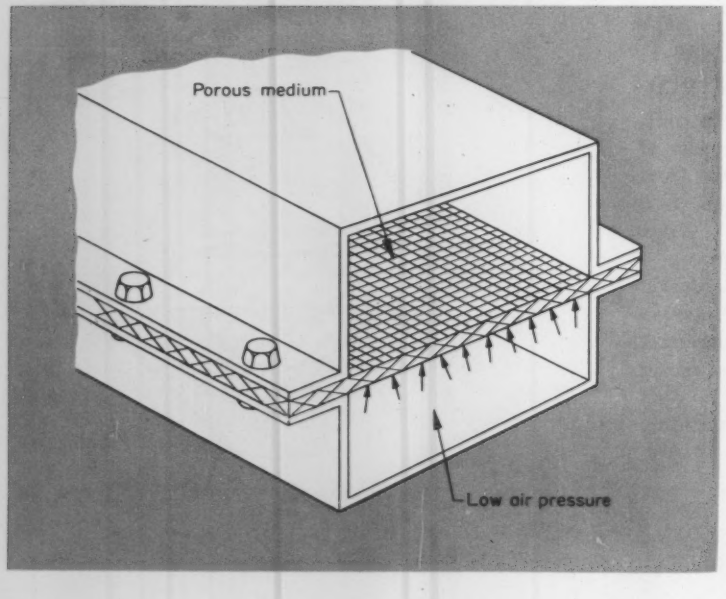




IRREVERSIBLE TORQUE CONTROL is provided by a single "sprag" which permits transmission of power in either direction of rotation from a drive member, but not from a driven member. The sprag is a simple lock bar, with a wedge surface at each end. When the drive member rotates, it compresses a spring between the lock bar and the driven member. This unlocks the wedge and permits the sprag to rotate without contacting the inner wall of a surrounding lock ring. When power is applied to the driven member, it wedges the lock bar against the lock ring, preventing rotation. The design was developed by Ann Arbor Bearing and Mfg. Co.



OFFSET SWITCH CONTACTS slide back and forth during opening and closing to prevent carbon build-up. Switch point centers are offset when closed. When switch blades open, switch points slide across one another and come to rest in the open position. In this position, switch point centers are offset in opposite direction. Sliding action cleans contacts during both the opening and closing operation. This design is employed in a centrifugal starting switch developed by Electric Motor Div., A. O. Smith Corp.



AIR CUSHION furnishes low-friction surface for transport of materials in gravity-flow conveyor. In the Fuller Airslide fluidizing conveyor, low-pressure air, introduced through a lower chamber, flows through a porous fabric surface. This air floats the material being conveyed and permits it to flow by gravity feed through the upper chamber.

By NAVIN KOTHARI
Plant Metallurgist
Dixon Sintaloy Inc., Stamford, Conn.

Heat-Treated Powder-Iron Parts

for improved strength and hardness

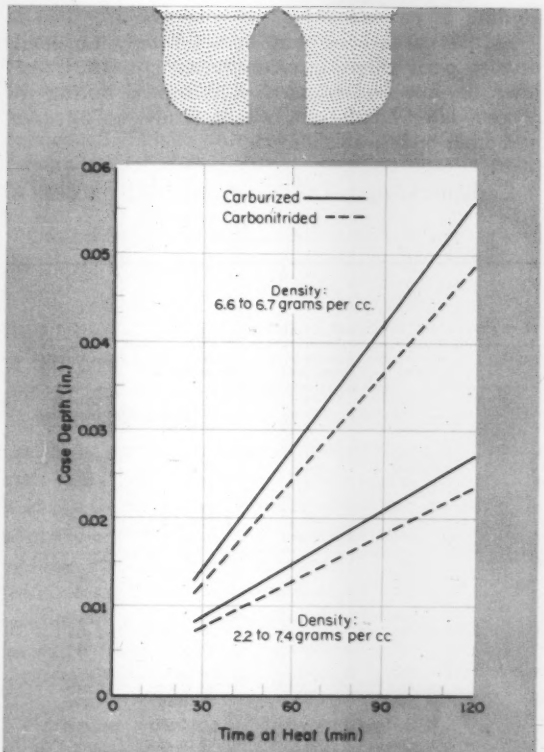


Fig. 1—Variation of case depth of carburized and carbonitrided iron-graphite parts with time at heat treating

PROPERTIES of ferrous parts produced by the powder-metal process can be improved by the same conventional heat-treatment techniques used on plain-carbon and low-alloy steels. Effects of heat treating on properties of ferrous parts have been studied extensively by Dixon Sintaloy Inc., and results indicate that it is now feasible to heat treat these parts on a production basis. However, metallurgical aspects of the powder-metal process are complex, and the influence of certain factors of composition on end properties must be considered prior to specifying heat treating. Data presented here show how such factors as density and porosity of the part, and type of iron powder, affect physical properties when parts are subjected to three conventional methods of heat treatment: Carburizing, carbonitriding, and carboaustenizing.

Carbon, in the form of graphite, added to iron-powder mixtures to produce medium or high-carbon steel, serves as an inexpensive way of improving physical properties of the part and also shortens the heat-treating cycle considerably. Particle size and purity of the carbon are key factors in developing physical properties of ferrous parts.

Test specimens were made from iron, iron-graphite, and iron-copper-graphite in three densities: Low, from 5.8 to 6.2 grams per cc; medium, 6.6 to 6.9; and high, 7.0 to 7.4. Properties of sintered-iron compacts are shown in Table 1 for comparison with those of heat-treated compacts. High-density parts are easily pack carburized, gas carburized, or

Table 1—Properties of Sintered Iron Compacts

Compact	Density (grams per cc)	Tensile Strength (psi)	Hardness (Rockwell B)	Elongation (per cent)	Transverse Rupture (psi)
Iron-Graphite	5.8 to 6.0	25,400	10 to 20	0 to 1	53,400
	6.6 to 6.8	43,600	20 to 35	1 to 2	71,670
	7.2 to 7.4	54,100	30 to 50	1 to 2	89,720
Iron-Copper-Graphite	5.9 to 6.1	45,000 to 48,000	40 to 50	0 to 1	97,000
	6.5 to 6.6	65,000 to 68,000	55 to 70	0.5 to 1	106,000
	7.2 to 7.4	78,000 to 81,000	85 to 98	0.5 to 1	127,000

liquid carburized, gas carbonitrided, or cyanided by conventional methods. Of these methods, gas carburizing, gas carbonitriding, and gas cyaniding give best control on case depth and composition, and can be adapted to all densities.

Carburizing: In this process of case hardening, carbon is introduced into iron-base alloys by heating the alloys in the austenitic range in contact with a carbonaceous material which may be solid, a liquid, or a gas. In solid and gas carburizing, a reaction occurs between the surface of the steel and the gas. Activated carbon is released; the amount absorbed into the part depends on four factors: Porosity, temperature, carbon potential, and diffusion coefficient. This reaction takes place in a temperature range from 1500 to 1800 F. Table 2 shows properties of powder-iron parts of various compositions after heat treating.

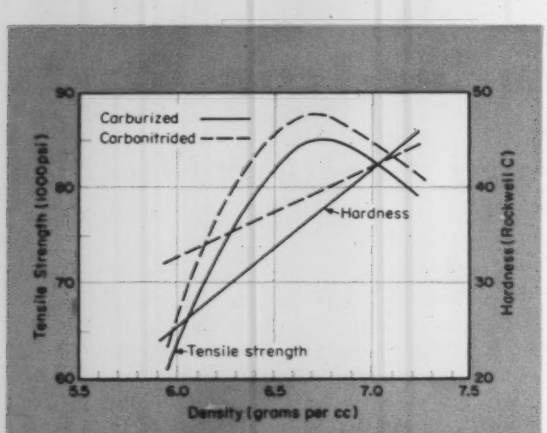


Fig. 2—Relation of tensile strength and hardness to density of carburized and carbonitrided powder-iron parts

Depth of case varies with density, type of iron powder, and time, Fig. 1. After pack carburizing or gas carburizing, parts are furnace cooled or quenched. It is important to protect the parts in suitable reducing atmospheres. Furnace-cooled specimens are somewhat similar to sintered parts in that they contain a desirable amount of carbon. Aside from this, however, there is little benefit derived from furnace cooling except in high-density parts, in which the amount of combined carbon can be increased and diffused fairly well into the core. Case depths of parts quenched from carburizing vary according to part density.

Liquid carburizing can be used only on high-density parts where interconnecting porosity is very low. In low-density parts, salt trapped during the process later bleeds out, which results in corrosion and other undesirable effects.

Carbonitriding: This is a modified process of

Table 2—Properties of Powder-Iron Parts After Heat Treating

Part Composition And Heat Treatment	Time at Heat	Density (grams per cc)	Tensile Strength (psi)	Yield Strength (psi)	Elongation (per cent)	Hardness (Rockwell C)	Case Depth (in.)
Iron-graphite, carburized at 1700 F	30 min	5.8 to 6.0	47,500	44,000	None	10 to 14	Through
		6.6 to 6.7	60,800	58,400	None	23 to 25	Not observed
		7.2 to 7.3	69,000	63,000	None	35 to 36	0.009
	60 min	5.8 to 6.0	49,900	48,100	0.3	15 to 17	Through
		6.6 to 6.7	65,900	65,000	None	27 to 28	0.029
		7.2 to 7.3	71,000	69,300	0.5	38 to 40	0.015
	120 min	5.8 to 6.0	61,300	61,100	None	20 to 25	Through
		6.6 to 6.7	85,100	83,200	None	36 to 40	0.056
		7.2 to 7.3	79,000	74,600	None	44 to 48	0.027
Iron-graphite, carbonitrided at 1640 F	30 min	5.8 to 6.0	48,000	43,000	None	15 to 18	Through
		6.6 to 6.7	59,000	49,800	None	24 to 26	0.012
		7.2 to 7.4	66,000	61,300	0.5	35 to 38	0.008
	60 min	5.8 to 6.0	49,000	44,800	None	20 to 21	Through
		6.6 to 6.7	69,000	67,000	None	30 to 35	0.026
		7.2 to 7.4	71,000	70,000	None	39 to 42	0.019
	120 min	5.8 to 6.0	63,000	61,700	None	30 to 34	Through
		6.6 to 6.7	87,600	81,000	None	38 to 40	0.049
		7.2 to 7.4	81,700	78,900	0.50	43 to 46	0.024
	Carbonitrided for 120 min and tempered at 350 F for 60 min	5.9	60,000 to 61,500	49,000 to 51,200	1.0	25 to 28	...
		7.2 to 7.3	78,600 to 79,500	66,200 to 67,300	1.1	35 to 38	....
	Carbonitrided for 120 min and tempered at 600 F for 60 min	5.9	48,100 to 50,000	33,000	1.5	10 to 12	....
		7.2 to 7.3	66,300 to 67,000	50,900 to 51,300	2.0	24 to 28	....
Iron-copper-graphite, carbonitrided at 1640 F	30 min	6.5 to 6.6	83,100	77,000	None	11 to 13	0.002
		7.2 to 7.3	90,000	88,200	None	25 to 30	Iron nitride
	120 min	6.5 to 6.6	103,700	92,100	None	28 to 34	0.0029
		7.2 to 7.3	113,000	112,100	None	35 to 38	....
	Carbonitrided for 120 min and tempered at 600 F for 60 min*	6.5 to 6.6	97,000	84,800	1.9 to 2.0	12 to 15	....
		7.2 to 7.3	102,000	89,300	2.0 to 2.1	20 to 23	....
Pure iron, carburized and tempered†	30 min	6.4 to 6.6	69,060	51,000	1.1	75 to 80	0.0112
		7.4 to 7.5	46,700	39,000	0.9	80 to 90	0.008
	120 min	6.4 to 6.6	109,000	91,100	1.8	85 to 90	0.062
		7.4 to 7.5	71,050	57,000	2.0	95 to 100	0.0296

*Tempering produced some parts with tough cores, increased elongation, and decreased strength.
†All compacts tempered at 600 F for 30 min.

carburizing in which both carbon and nitrogen are diffused into the structure. Diffusion is accomplished by a sodium-cyanide bath and activated carbonaceous compound, or by a combination of hydrocarbon and ammonia gases. Depth of the case is not as great as in the carburized specimen, Fig. 1, but the surface is very hard. Diffusion of carbon into the part is prevented by formation of iron nitride. Amount of carbon and nitrogen absorbed into the part depends more on the density of the part than on the composition of reacting gases.

Carbonitriding is usually carried out at a somewhat lower temperature than carburizing. Since austenite transformation is very slow, distortion is reduced considerably on quenching. Sintered-iron parts are processed from 20 min to 8 hr at temperatures from 1550 to 1640 F depending upon density and size, Table 2.

Carboaustenizing: This process minimizes distortion on sintered parts. Compacts are brought to carburizing temperature, held to obtain the required amount of carbon, and cooled below the transformation temperature. The compact is then brought to the normalizing temperature, between 1450 and 1500 F, held for transformation, and quenched. This technique is generally used on high-density parts but is useful for medium-density parts as well.

Quenching: Low and medium-density parts must

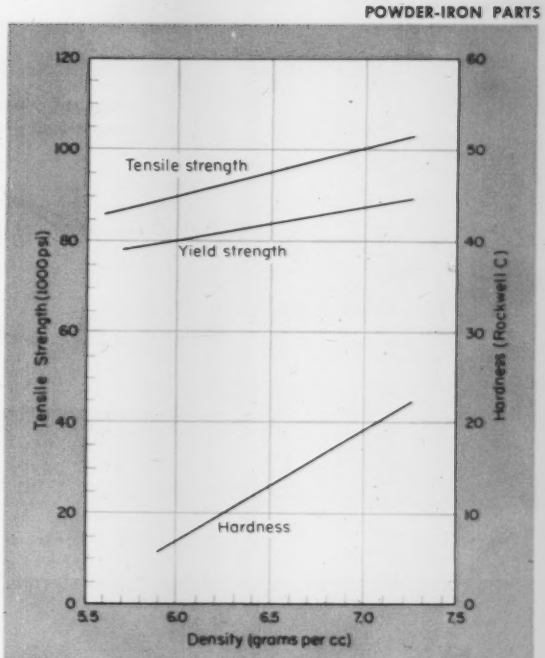
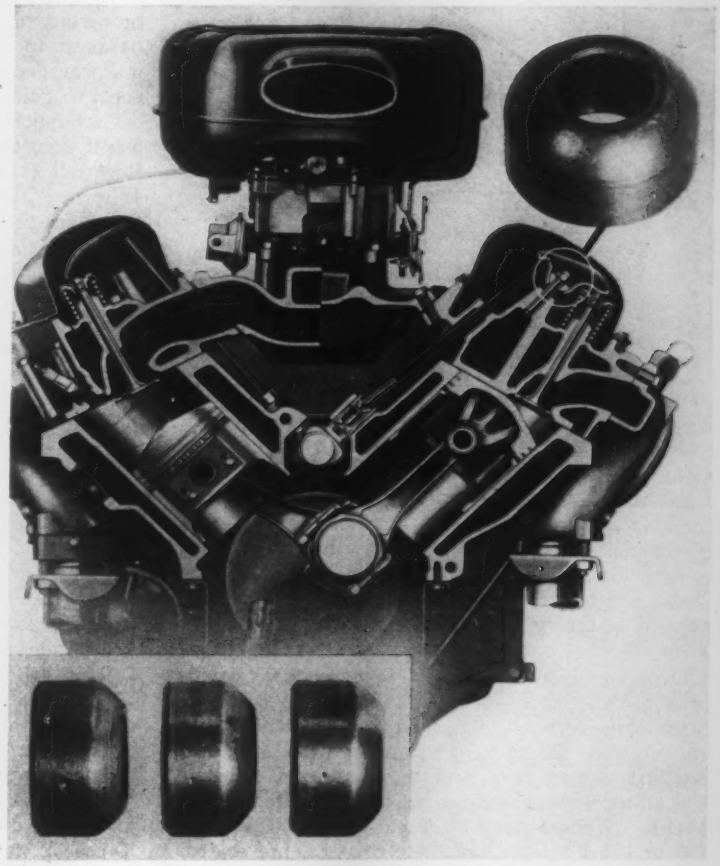


Fig. 3—Effects of density on tensile strength, yield strength, and hardness of iron-copper-graphite parts carbonitrided at 1640 F for 120 min and tempered at 600 F for 60 min

High strength and hardness of this powder-iron part is the result of selective heat treatment. Compression loads to 45,000 psi are withstood by the valve rocker arm ball 1800 times per minute. Accurately controlled density and porosity of the part allow lubricant to feed through to contacting surfaces under high pressure and speeds. This part replaces a ball formed from 90,000-psi cold-rolled and cyanide-hardened steel.

Hardness attained by heat treating for 120 min is evident from depth of indentation caused by a Rockwell hardness tester. Valve rocker-arm ball in the "as-sintered" condition, left; after carburizing, center; and after carbonitriding, right. Density of iron-graphite parts is 5.9 to 6.0 grams per cc. Hardness increased from Rockwell B 10-15 for the as-sintered part, to Rockwell C 10-15 for the carburized part, and to Rockwell C 20-25 for the carbonitrided part.



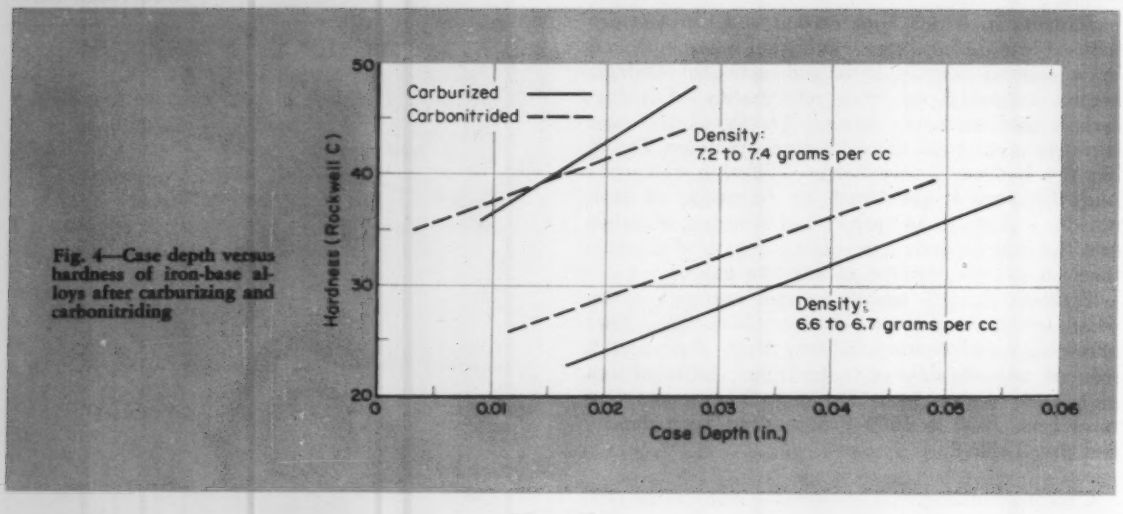


Fig. 4—Case depth versus hardness of iron-base alloys after carburizing and carbonitriding

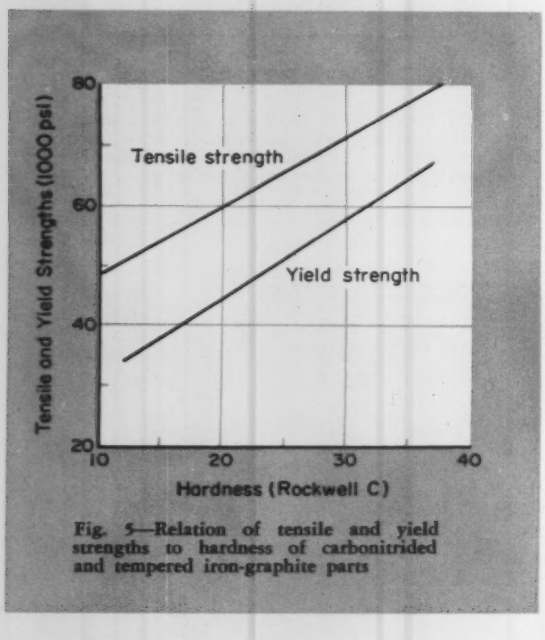


Fig. 5—Relation of tensile and yield strengths to hardness of carbonitrided and tempered iron-graphite parts

be quenched with caution because of reduced heat conductivity and evolution of gas caused by entrapment of the quenching medium. Pores, acting as stress raisers, sometimes cause severe distortion or cracking during quenching, especially if the part is complex in shape or relatively heavy in cross section. It should be made certain that quenching media are free from impurities which can become trapped in the structure of the part.

Heat-Treatment Procedure: Test specimens (made in accordance with MPA Standard 10-50T) were carburized, carbonitrided, and carboaustenized for 30, 60, and 120 min. Propane provided the carburizing atmosphere, and a mixture of propane and ammonia was used for the carbonitriding atmosphere. Temperature of the quench was kept at 100 to 125 F. Effects of these processes are evident from a comparison of properties of the materials in the as-sintered condition, Table 1, with the properties induced by heat treating the same materials, Table 2. Resultant properties are somewhat similar to those of plain carbon and low-alloy steel.

Property Variations: Properties shown in Table 2 are difficult to reproduce unless variations, due to uneven density of the part, are controlled. Uneven density causes nonuniform case depth and properties, especially in low-density parts. While hardness in steel is a function of carbon content, uniform density is essential in iron-powder compacts to gain a strength comparable to steel.

Carbonitrided iron-graphite compacts of three different densities gave hardness readings of 25 to 45 Rockwell C after quenching. When tempered for 1 hr at 350 and 600 F, compacts with the 5.8 to 6.0 grams per cc density were found to be softer than the compacts of 7.2 to 7.4 grams per cc density. This could be due to the porous structure of the materials. The effect is even more prominent if the compacts are tempered at higher temperatures.

Tensile and yield strengths of iron-graphite compacts increase after heat treatment and are related directly to density, Fig. 2. Tensile strength decreases beyond a density of 6.6 grams per cc because of a lack of complete diffusion of carbon in compacts of higher densities. That tensile strength, yield strength, and hardness increase with density of iron-copper-graphite compacts after heat treatment is shown in Fig. 3. Relation between case depth, hardness, and density of iron-graphite compacts is shown in Fig. 4. Elongation of these compacts is poor, Table 2, compared to carbon steel, but yield and tensile strengths are close, Fig. 5.

It is logical that higher density materials have higher tensile and yield strengths than lower density materials since a greater volume of metal is stressed. This is not true, however, if the high-density material is heat treated for a relatively short time. If small-size, high-density compacts are heat treated for a long enough time to attain complete diffusion of carbon, tensile strength would be very high.

Methods of

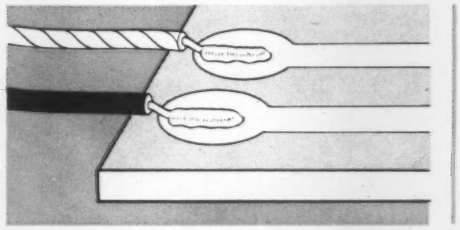
Attaching Leads

to printed-circuit boards

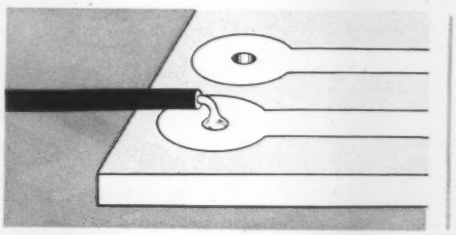
By FRANK WILLIAM WOOD Jr.
Design Engineer
Vitro Laboratories
Silver Spring, Md.

Design popularity of printed-circuit wiring in electronic equipment continues to grow. Cost-reduction possibilities in wiring electronic gear with "printed boards" is the one big reason. Cost savings can be tremendous in high-volume production using printed-circuit boards.

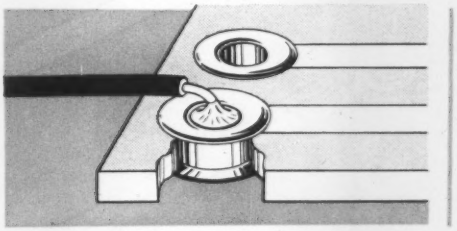
However, cost advantages of printed-circuit wiring can be all but wiped out if an expensive method of attaching electric leads is chosen. Of course, leads can be connected directly to printed-



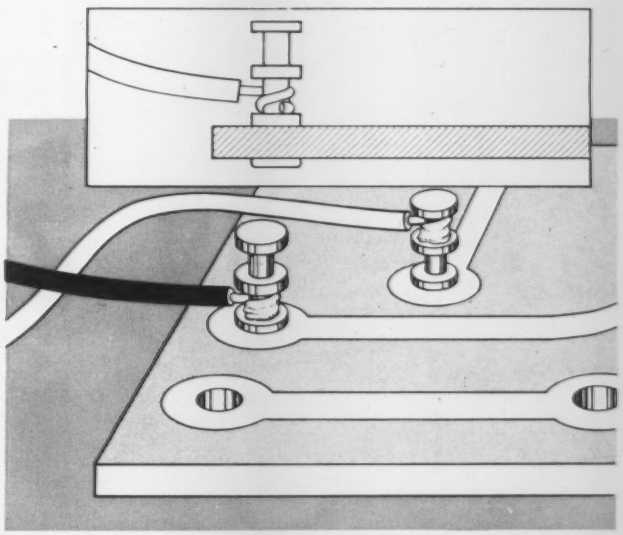
1 **Direct soldering** of leads to printed wiring is a simple, low-cost method of attachment. No drilling or slotting of the board is required. This type of connection does not provide a good mechanical connection. Also, repeated heating and removal of leads causes the printed circuit to separate from base material.



2 **Tinned leads** soldered in drilled holes eliminate the need of an electric connector, but the mechanical connection is poor.

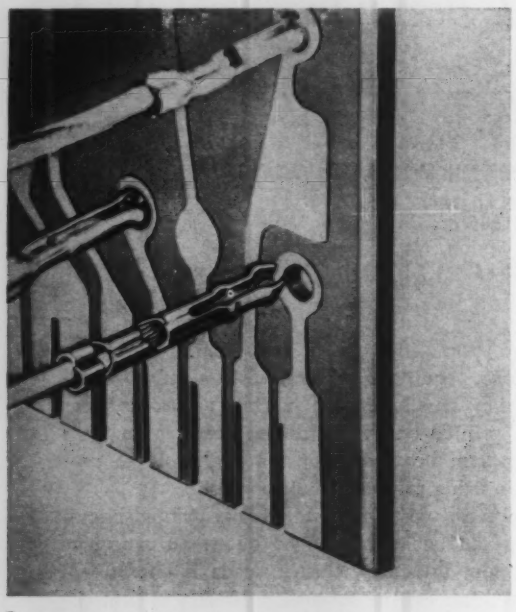


3 **Leads soldered** in eyelets, which are swaged in printed-circuit boards, provide a good electrical contact and a low-cost connection. Here, too, it takes time to attach and remove leads.



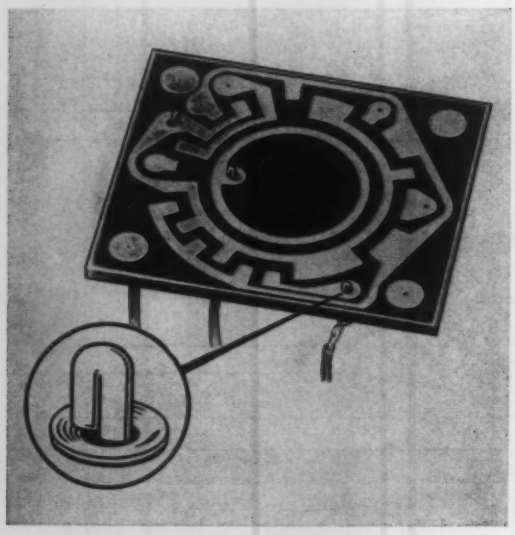
4 **Terminals swaged** to printed boards offer good mechanical and electrical connection with soldered-lead connections. This design allows termination of leads from areas of the board other than edges.

circuit wiring by soldering or even welding. But manufacturers also supply many types of electric connector components designed especially for application on printed-circuit boards. A design comparison of several methods for attaching leads to printed boards is presented here.

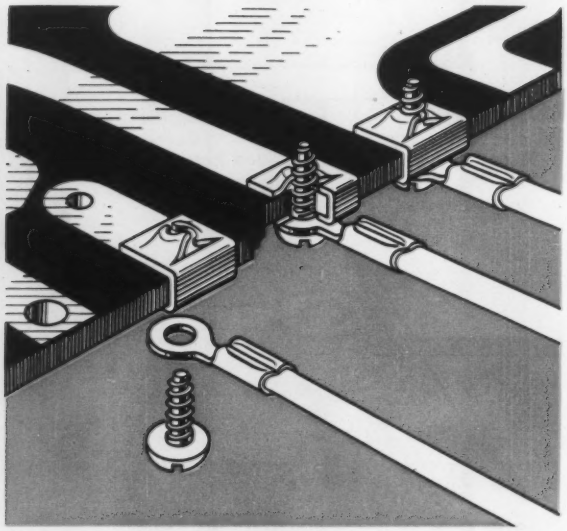


5 **Snap-in self-retaining connectors** permit quick insertion and removal.

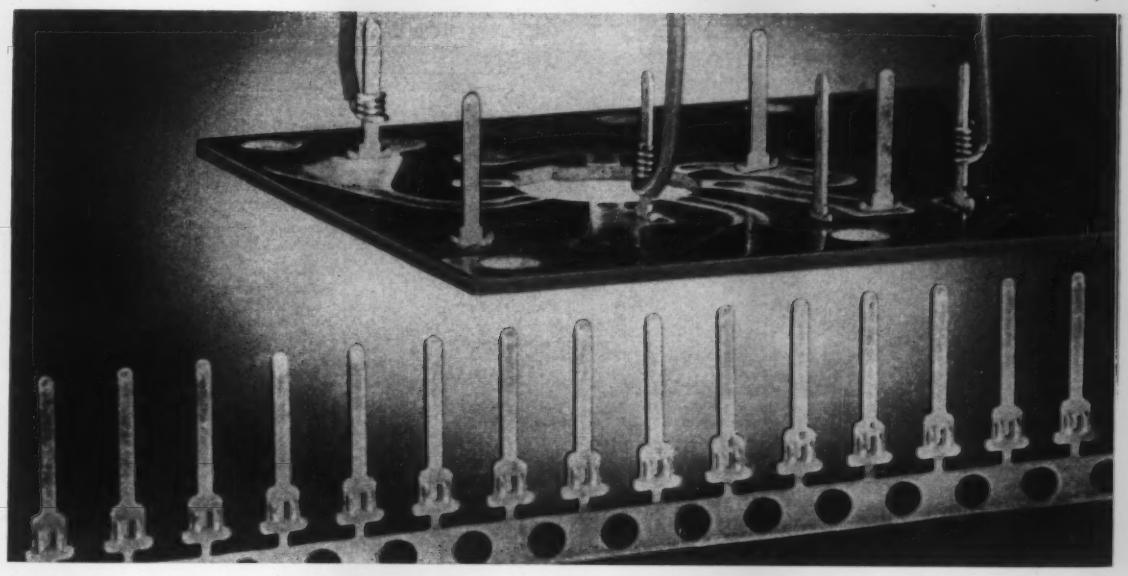
7 **Slide-in electric connectors** formed of U-shaped plugs assure positive contact in a slotted receptacle. Slots are sawed in board at side of each termination.



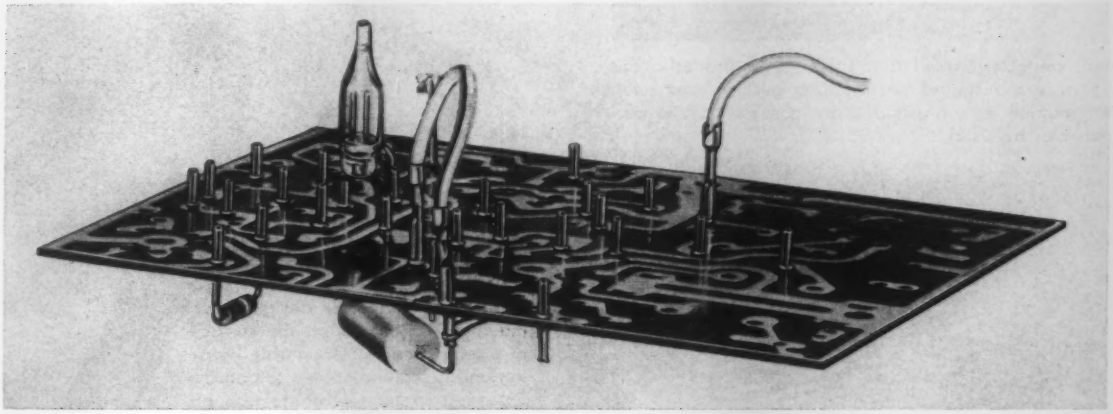
6 **Push-through self-locking connectors** for terminals are designed to assure good mechanical connection.



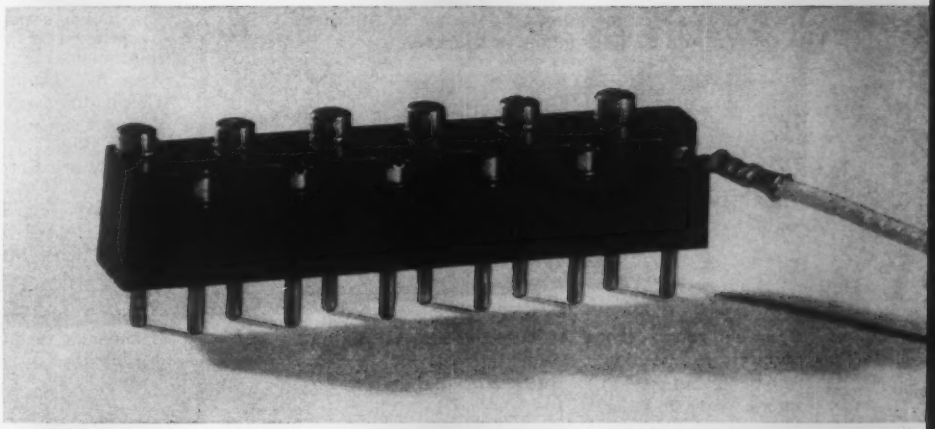
8 **Slide-on threaded fasteners** firmly grip printed-terminal areas. When wires are mounted to the self-retaining nuts with screws, mechanical and electrical connections are good. Clearance holes are drilled for screws.



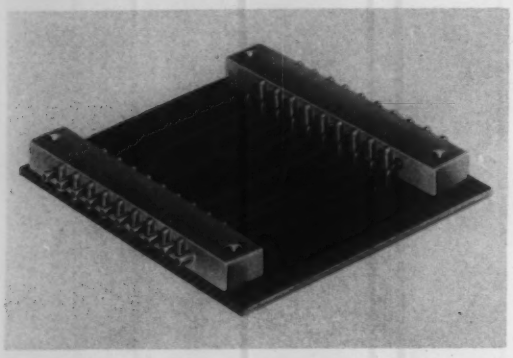
9 **Wire-wrap terminals** inserted and clinched to printed boards make good mechanical and electrical connections. Suitable for automatic production installation, leads are attached to terminals with special tools. Terminals are available in loose or chain form.



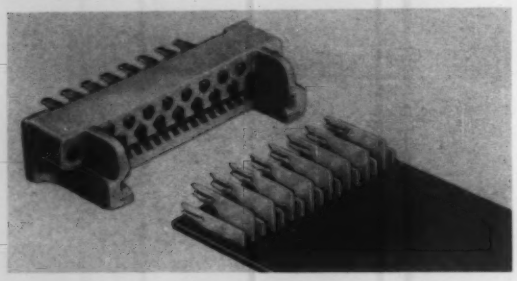
10 **Miniature tubular pins** for wire terminations snap into printed boards. Pins can be permanently soldered in place. Available in chain form, pins are suitable for automatic insertion.



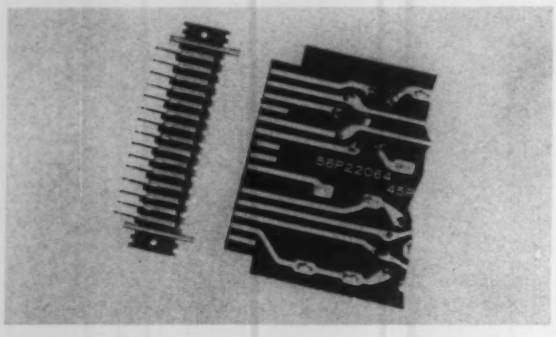
11 **Plastic terminal block** made specifically for printed-circuit boards. Lead-fastening screws mate with the pins which extend through the block. The pins are soldered to the printed wiring.



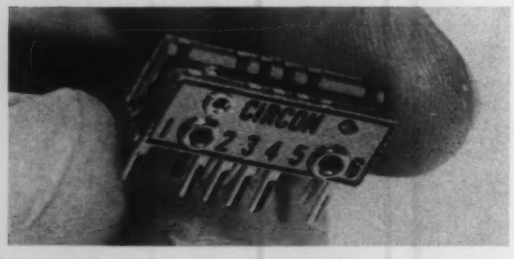
12 **Plastic connection block** designed for soldering to printed boards. Wire leads are attached to tapered pins and plugged into the connection block.



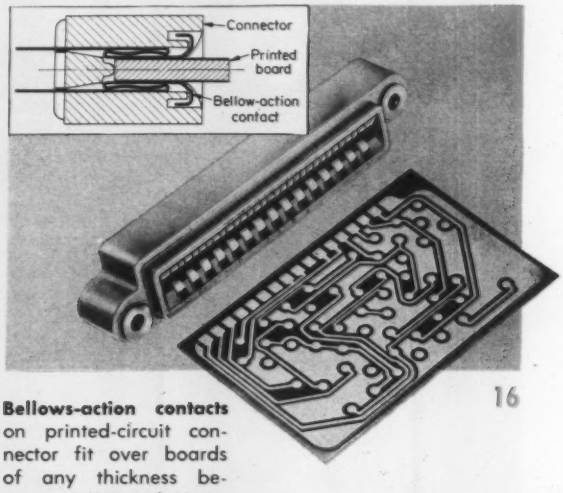
13 **Fork contacts,** staked and soldered to printed-circuit board, are designed for a mating push-on connector. Any number of contacts and any contact-location pattern can be used.



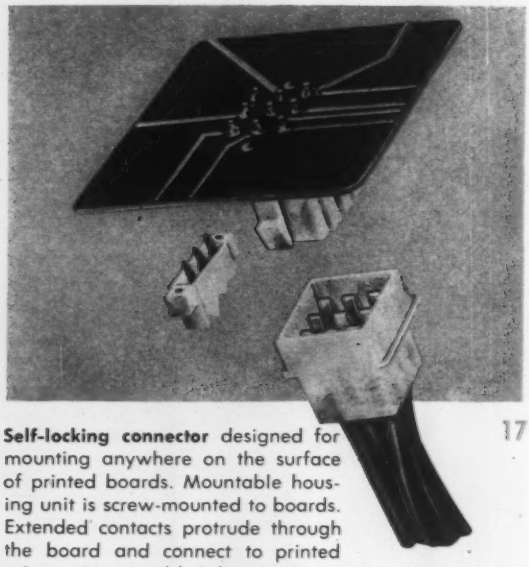
14 **Open-construction edge connector** permits quick insertion and removal of board and has no "pockets" which can collect moisture. Connector is attached to chassis on mounting angles or brackets.



15 **Open-end edge connector** can be slid on printed board from one side. Design prevents moisture entrapment, but keying or stops must be used to assure correct alignment.



16 **Bellows-action contacts** on printed-circuit connector fit over boards of any thickness between 1/16 and 1/8 in.



17 **Self-locking connector** designed for mounting anywhere on the surface of printed boards. Mountable housing unit is screw-mounted to boards. Extended contacts protrude through the board and connect to printed wires prior to solder dipping.

ACKNOWLEDGEMENT

The author acknowledges with appreciation the co-operation of these companies in supplying illustrations:

Amp. Inc. (Fig. 5, 7, 17) .....Harrisburg, Pa.
Cinch Mfg. Corp. (Fig. 14) .....Chicago, Ill.
Circon Component Corp.
(Fig. 15) .....Goleta, Calif.
DeJur-Amsco Corp.
(Fig. 12, 16) .....Long Island City, N. Y.
Elco Corp. (Fig. 13) .....Philadelphia, Pa.
Harvey Hubbell Inc. (Fig. 6) .Bridgeport, Conn.
Kulka Electric Mfg. Co. Inc.
(Fig. 11) .....Mount Vernon, N. Y.
Malco Tool & Mfg. Co.
(Fig. 9, 10) .....Chicago, Ill.
Tinnerman Products Corp.
(Fig. 8) .....Cleveland, Ohio

Design Guide

FLEXIBLE COUPLINGS

By LEO F. SPECTOR
Associate Editor

Forms

Capacities

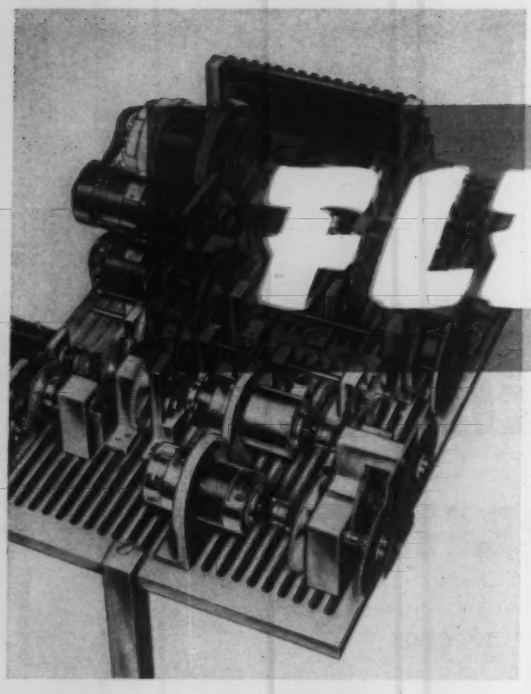
Maximum Speeds

Deflection Characteristics

Sizes

Design Options

Manufacturers



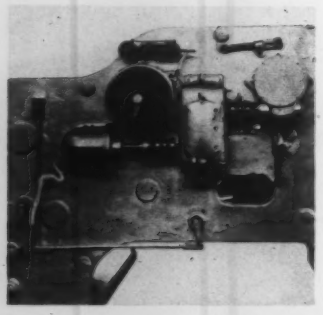
FLEXIBLE

Which coupling for the job?

Here is practical help in finding the answer . . . detailed information on 100 basic forms of flexible couplings manufactured in this country.

Flexible couplings are design "insurance." They guard drive systems against:

- **Misalignment not great enough to require a universal joint or flexible shafting.**
- **End play between shafts.**
- **Vibration, shock, and noise.**

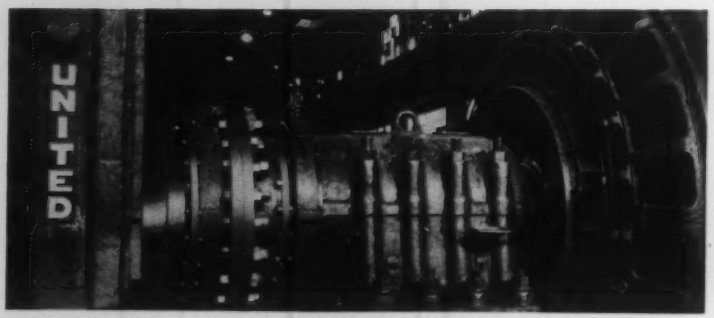


FOR ease of reference, flexible couplings covered in this Guide are grouped in six categories:

1. Instrument and servo drives ..... Page 104
2. Chain type 108
3. Gear type 112
4. Metallic flexible members 116
5. Nonmetallic flexible members 118
6. Slider type 127

Couplings in the first group include those types developed primarily for servomechanisms, instruments, and other similar drive and control systems. In such systems power requirements are low and accuracy of transmission is usually emphasized. On a capacity basis, these units fall generally into the subfractional-horsepower range although some are offered in fractional-horsepower sizes.

Couplings in the other five groups include the various well-established forms developed for general-purpose application as well as special-purpose types. Capacities are mainly in the integral-horsepower range. For certain designs in both the gear-



COUPLINGS

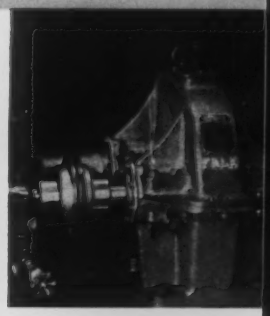
type and metallic-flexible-members groups, ratings to 40,000 hp and higher are possible. However, fractional-horsepower sizes are also offered in a number of designs. Some types, such as those employing nonmetallic flexible members, extend into the subfractional range.

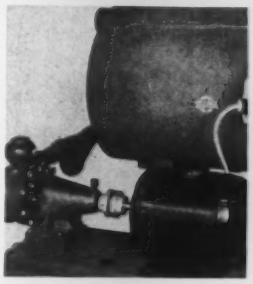
Data on forms, capacities, maximum speeds, deflection characteristics, and sizes are representative of the standard models of a line. Range between smallest and largest standard coupling sizes is indicated by minimum and maximum values.

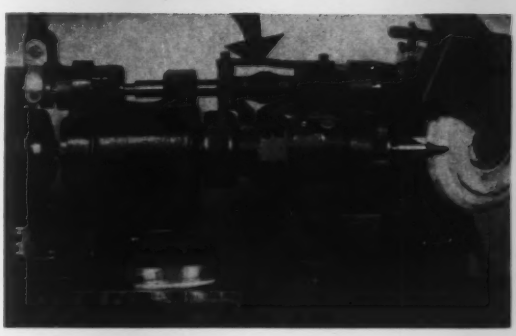
Ratings of flexible couplings are based on torque capacity. However, practices for determining rating values are not standardized and vary among manufacturers. As a rule, these values are in horsepower per 100 rpm. Capacities given here represent nominal or basic ratings as specified by each manufacturer. Where torque rating is not constant, ratings at two speeds are provided to indicate the degree of variation. In practice, determination of the proper coupling rating may or may not require an allowance for load and operating conditions. Recommendations for each coupling should be followed in specific applications.

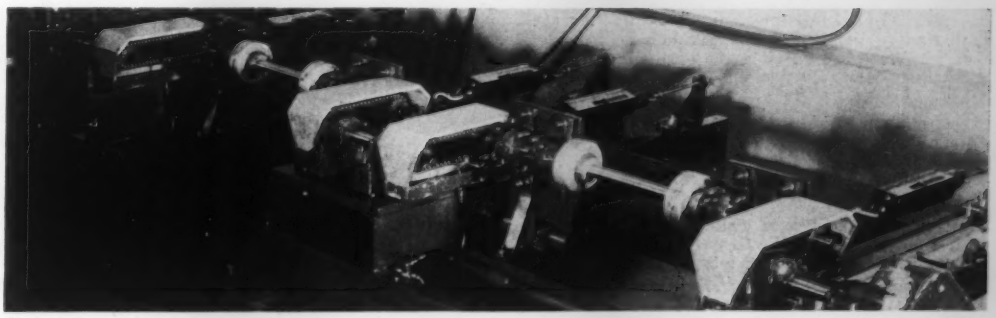
Values of misalignment and end play given are maximums that can be reached individually but usually not in combination. Under combination conditions, most manufacturers recommend that these misalignment and end-play values be reduced.

Torsional-flexibility ratings represent the torsional deflection of the couplings at rated torque.





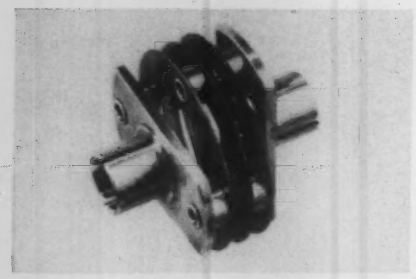




FLEXIBLE COUPLINGS

instrument and servo drives

Beckman Flexible Disc



Form: Two stainless steel flanged hubs riveted to a flexible center member consisting of three beryllium-copper disc elements riveted to each other. Adjacent pairs of rivets in the hub-disc construction are displaced 90 deg.

Capacity: Maximum torque, 32 oz-in.

Maximum Speed: 1000 rpm.

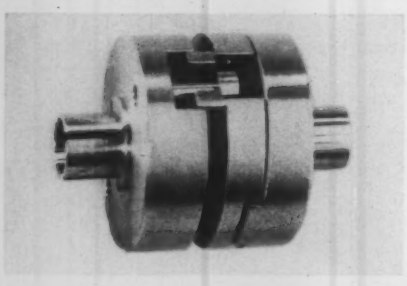
Deflection Characteristics: Angular misalignment, 2 deg. Limited end play. Zero parallel misalignment and torsional flexibility.

Sizes: Bore, 1/8 to 1/4 in. OD, 1 in. Length, 1 3/32 in.

Design Options: Pin or clamp type hubs.

Manufacturer: Helipot Div. of Beckman Instruments Inc., Fullerton, Calif.

Beckman Oldham



Form: Two flanged hubs connected by a spring-loaded disc slider element. One disc face, which is separated from flange face by spring, has tongue projection which fits into slot in face of flange and is loosely held in place by retaining pins. Other disc face has slot which engages tongue projection on flange of companion hub in free fit. Construction permits relative sliding movement of flanges and disc. All stainless steel construction.

Maximum Speed: 2000 rpm.

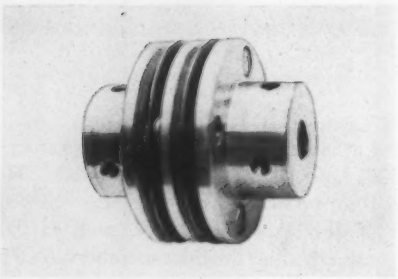
Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 1/64 in. Limited end play. Zero torsional flexibility.

Sizes: Bore 1/8 to 1/4 in. OD, 3/4 and 1 in. Length, 1 1/4 and 1 7/32 in.

Design Options: Pin or clamp type hubs. Modified units with fully floating slider have higher maximum speed but do not compensate angular misalignment.

Manufacturer: Helipot Div. of Beckman Instruments Inc., Fullerton, Calif.

Dial



Form: Two flanged aluminum hubs riveted to flexible center member consisting of either one beryllium-copper membrane or two membranes which are riveted to intermediate aluminum disc.

Capacity: Torque rating, 35 to 40 lb-in.

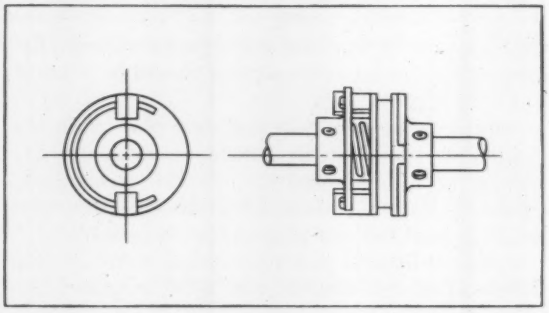
Deflection Characteristics: Angular misalignment, 3 to 7 1/2 deg. Parallel misalignment, minimum for one-membrane and 0.010 to 0.015 in. for two-membrane units. End play, 0.025 to 0.060 in. Torsional flexibility, 0.012 to 0.030 radians.

Sizes: Bore, 1/8 to 1/2 in. OD, 15/16 to 1 5/16 in. Length, 25/32 to 1 9/32 in.

Design Options: Floating-shaft type coupling. Special hub shapes and materials.

Manufacturer: Dial Products Co., Bayonne, N. J.

Ford Instrument Oldham



Form: Two flanged hubs connected by a metal disc center element. Two lug projections, 180 deg apart, on each face of disc engage mating slots in edge of each flange. Lug pairs are displaced 90 deg. Lugs on one disc face, which is separated from flange by a coil-spring section, are held in place by wire retaining clip; lugs on other face are free fit in slots. All stainless steel construction. Hubs are designed for pin attachment to shafts.

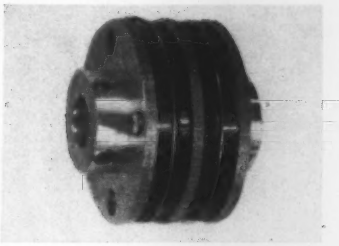
Capacity: Governed by shear strength of pin attachment. (Max diam, 0.074 in.)

Deflection Characteristics: Angular misalignment, zero. Parallel misalignment, 0.03 in. End play, 0.06 in. Zero torsional flexibility.

Sizes: Bore 3/16 to 5/16 in. OD, 1.13 in. Length, 1.09 in. (max).

Manufacturer: Ford Instrument Co., Div. of Sperry Rand Corp., Long Island City, N. Y.

Kenilworth



Form: Two flanged aluminum hubs riveted to a flexible center member consisting of two stainless spring steel discs riveted to an intermediate aluminum disc.

Capacity: Torque rating, 32 oz-in.

Maximum Speed: 10,000 rpm.

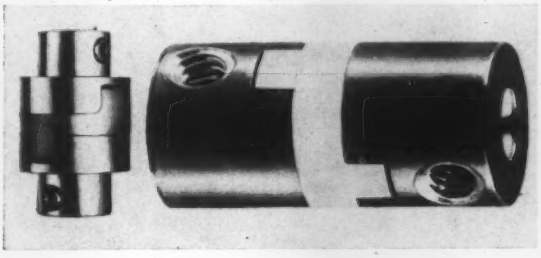
Deflection Characteristics: Angular misalignment, 5 deg. Zero parallel misalignment, end play, and torsional flexibility.

Sizes: Bore, 1/8 to 5/8 in. OD, 1 and 1.5 in. Length, 0.8 and 1.2 in.

Design Options: Special bores.

Manufacturer: Kenilworth Coupling Co., Asheville, N. C.

Kupfrian Oldham



Form: Two metal hubs connected by a nylon or Delrin disc slider element. Tongue projections across each face of disc and displaced 90 deg from each other engage mating slots in the face of each hub. Floating disc construction permits relative sliding movement of the hub and disc members.

Capacity: Static torque rating (intermittent operation), 8 to 32 lb-in. Running torque rating (continuous operation at 1000 rpm), 3 to 12 lb-in.

Maximum Speed: 2000 rpm.

Deflection Characteristics: Angular misalignment, 3 to 5 deg. Parallel misalignment, 1/32 to 1/16 in. Limited end play and torsional flexibility.

Sizes: Bore, 1/16 to 3/8 in. OD, 3/8 to 5/8 in. Length, 5/8 to 1 1/4 in.

Design Options: Aluminum, stainless steel or brass hubs. Subminiature and midget types. Special coupling constructions.

Manufacturer: Kupfrian Mfg. Corp., Binghamton, N. Y.

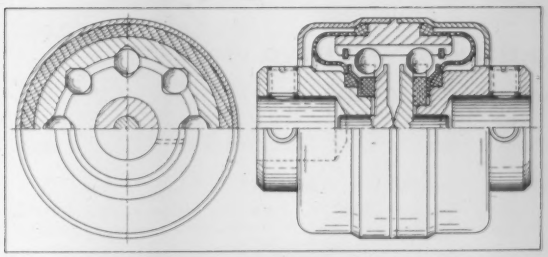
Metro-Flex

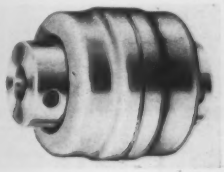
Form: Two aluminum hubs connected by a sleeve and hardened ball bearings which are mounted in special raceways. Each hub carries one row of ball bearings which ride in pockets of hardened inner raceways. Outer raceways, which are also hardened, are provided by axial grooves along the full length of the inner surface of the sleeve. Ball retainers on the hub and snap rings at the ends of the sleeve keep the balls in place. Operating assembly is prelubricated and sealed by a Hycar diaphram seal enclosed within an aluminum housing.

Capacity: Torque rating, 150 oz-in.

Maximum Speed: 10,000 rpm.

Deflection Characteristics: Angular misalignment, 5 deg.



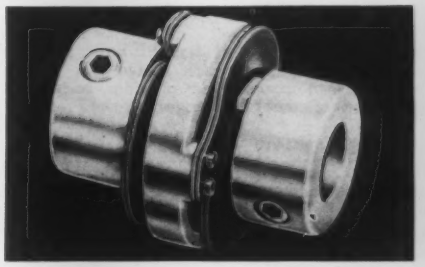


Parallel misalignment, 0.010 in. End play, 0.090 in. Minimum torsional flexibility.

Sizes: Bore 3/16 to 3/8 in. OD, 1 5/64 in. Length 1.312 to 1.438 in.

Manufacturer: Metron Instrument Co., Denver, Colo.

Naugler



Form: Two aluminum hubs riveted to flexible center member consisting of either one pair of intertwined C-shaped beryllium-copper leaves or two pairs of leaves riveted to an intermediate aluminum disc.

Capacity: Torque rating, 4 to 500 oz-in.

Maximum Speed: 4000 rpm.

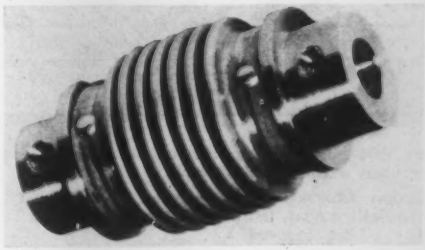
Deflection Characteristics: Angular misalignment, 4 to 8 deg. Parallel misalignment, zero for units with one pair of leaves and 0.015 to 0.030 in. for units with two pairs of leaves. End play, 0.007 to 0.045 in. Torsional flexibility, 0.5 to 0.8 deg (approx).

Sizes: Bore, 0.1562 to 0.500 in. OD, 1/2 to 1 1/2 in. Length, 0.63 to 1.70 in.

Design Options: Special coupling sizes and materials.

Manufacturer: Naugler Engineering Inc., Beverly, Mass.

PIC Bellows



Form: Two hubs connected by a bellows section in a three-piece assembly. All stainless steel design.

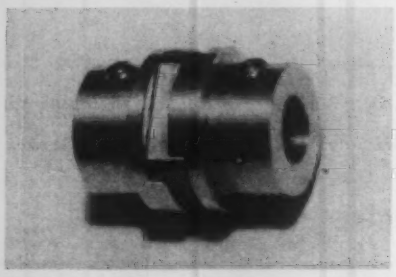
Deflection Characteristics: Angular misalignment, 2° deg. Parallel misalignment, 0.010 in. Zero end play and torsional flexibility.

Sizes: Bore, 0.1200 to ¼ in. OD, 51/64 in. Length, 1½ in.

Design Options: Pin or clamp type hubs. Zero adjustable bellows coupling provides 360 deg fine vernier adjustment for servo applications.

Manufacturer: PIC Design Corp., Subsidiary of Benrus Watch Co. Inc., East Rockaway, L. I., N. Y.

PIC Oldham



Form: Two stainless steel flanged hubs connected by a four-sided slider member. Each flange has two projecting jaws which engage opposite sides of slider, permitting relative sliding motion of the two flanges at right angles to each other.

Maximum Speed: 1000 rpm.

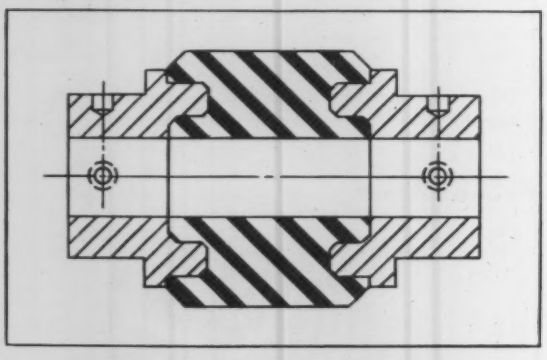
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 0.010 in. Zero end play and torsional flexibility.

Sizes: Bore, 0.1200 to ¼ in. OD, ⅝ in. Length, 21/32 to ¾ in.

Design Options: Oilless bronze or nylon sliders. Pin or clamp type hubs. Coupling variations include conventional cross type, spring-loaded, and fixed slider designs.

Manufacturer: PIC Design Corp., Subsidiary of Benrus Watch Co. Inc., East Rockaway, L. I., N. Y.

PIC Precision



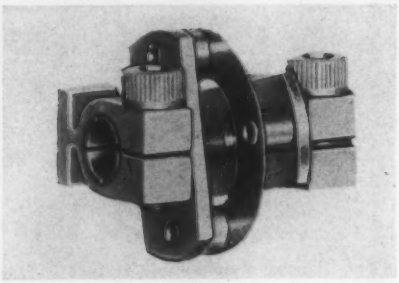
Form: Two stainless steel hubs connected by molded Neoprene rubber section in a one-piece construction.

Deflection Characteristics: Angular misalignment, 5 deg. Parallel misalignment, 0.010 in. Limited end play. Torsional flexibility, 10 deg (approx).

Sizes: Bore, 0.1200 to ¼ in. OD, 13/16 in. Length, 1¼ in.

Manufacturer: PIC Design Corp., Subsidiary of Benrus Watch Co. Inc., East Rockaway, L. I., N. Y.

Reeves Disc



Form: Two flanged hubs riveted to a flexible metal disc. Rivet points are displaced 90 deg.

Capacity: Torque rating, 50 oz-in.

Maximum Speed: 5000 rpm.

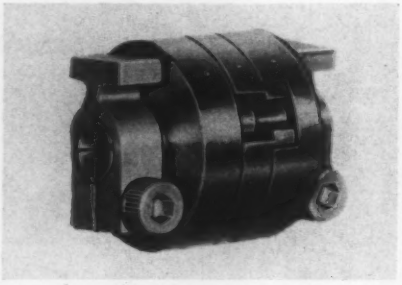
Deflection Characteristics: Angular misalignment, 2 deg. Zero parallel misalignment and torsional flexibility. Limited end play.

Sizes: Bore, ¼ in. OD, 1 in. Length, 61/64 to 1 5/64 in.

Design Options: Pin or clamp type hubs.

Manufacturer: Reeves Instrument Corp., Garden City, N. Y.

Reeves Oldham



Form: Two flanged metal hubs connected by a metal disc slider element. Engagement of hubs and disc is accomplished by tongue-and-groove joint on each side of disc, displaced 90 deg from each other. Floating disc construction permits relative sliding movement of flanges and disc.

Capacity: Torque rating, 50 oz-in.

Maximum Speed: 2500 rpm.

Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 1/64 in. Zero end play and torsional flexibility.

Sizes: Bore, ⅛ and ¼ in. OD, ½ to 1 in. Length, ¾ to 1 7/32 in.

Design Options: Pin or clamp type hubs. Slider element can be full floating or loosely attached to one hub. Coupling variations include miniature units with clamp type hubs in ⅛ to 3/16 in. bores.

Manufacturer: Reeves Instrument Corp., Garden City, N. Y.

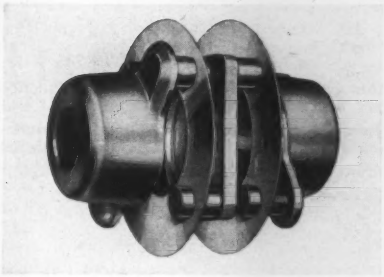
Renbrandt

Form: Two flanged hubs riveted to a flexible center member consisting of two stainless spring steel discs riveted to an intermediate square-shaped metal element.

Deflection Characteristics: Angular misalignment, 5 deg. Parallel misalignment, 0.015 to 0.020 in. Limited end play. Zero torsional flexibility.

Sizes: Bore, 1/16 to ½ in. OD, ¾ to 1½ in. Length, 7/16 to 1 55/64 in.

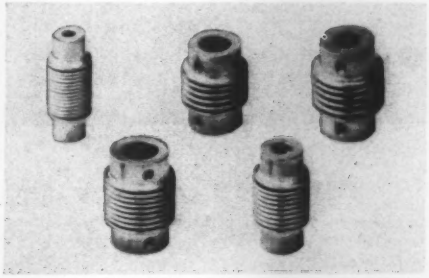
Design Options: Clamp or set-screw type hubs of brass or aluminum. Coupling variations include parallel, offset, or reverse-hub arrangements, and single-disc design for float-



ing-shaft applications.

Manufacturer: Renbrandt Inc., Boston, Mass.

Robertshaw-Fulton



Form: Two hubs connected by a one-piece phosphor-bronze or beryllium-copper bellows.

Maximum Speed: 10,000 rpm.

Deflection Characteristics: Angular misalignment, 5 to 11 deg depending on bellows material. Parallel misalignment, 1/64 to 1/16 in. End play, 0.050 to 0.150 in. Zero torsional flexibility.

Sizes: Bore, 1/8 to 1/2 in. OD, 15/32 to 15/16 in. Length, 57/64 to 1 3/32 in.

Design Options: Stainless steel or Monel construction. Special hubs, bores, materials, or coupling sizes.

Manufacturer: Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co., Milford, Conn.

Sterling Bellows

Form: Two metal hubs connected by a phosphor-bronze bellows in a one-piece construction.

Maximum Speed: 2000 rpm.

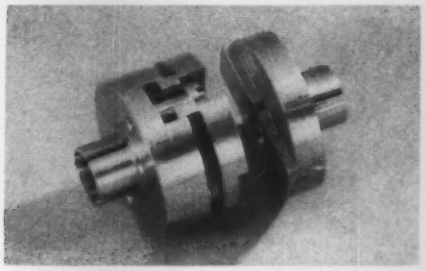
Deflection Characteristics: Angular misalignment, 5 deg. Limited parallel misalignment, end play, and torsional flexibility.

Sizes: Bore, 1/8 to 1/4 in. OD, 15/32 in. Length, 3/4 and 1 in.

Design Options: Solid and clamp type hubs.

Manufacturer: Instrument Div., Sterling Precision Corp., Flushing, N. Y.

Sterling Oldham



Form: Two flanged hubs connected by a floating disc slider element. Disc is loosely attached to one flange which has slot across face to receive projecting tongue on disc face. Other face of disc has slot for assembly with tongue on companion flange. Slot and tongue on opposite faces of disc are displaced 90 deg from each other. Floating disc construction permits relative sliding motion of flanges and disc. All-stainless steel construction.

Maximum Speed: 3000 rpm.

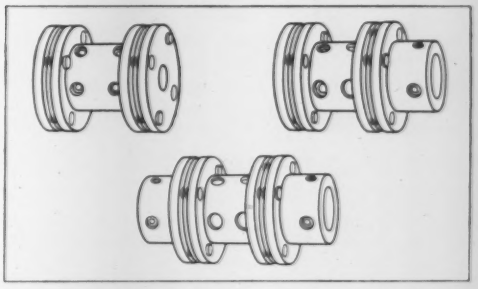
Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 0.015 in. Zero end play and torsional flexibility.

Sizes: Bore, 1/8 to 3/8 in. OD, 3/4 and 1 in. Length, 0.945 to 1.406 in.

Design Options: Pin or clamp type hubs.

Manufacturer: Instrument Div., Sterling Precision Corp., Flushing, N. Y.

Thomas Miniature



Form: Two aluminum-alloy flanged hubs connected by beryllium copper discs, which are riveted alternately to flanges on the hubs and at the ends of a tubular aluminum-alloy center element.

Capacity: Torque rating, 3.1 to 60 lb-in.

Maximum Speed: 50,000 rpm.

Deflection Characteristics: (approx) Angular misalignment, 4 deg. Parallel misalignment, 0.035 to 0.060 in. End play, 0.015 to 0.025 in. Zero torsional flexibility.

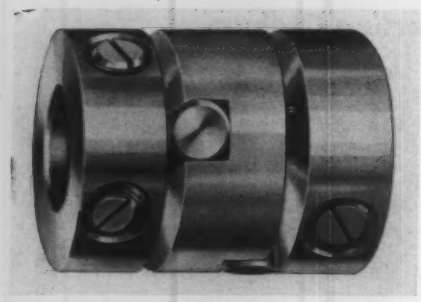
Sizes: Bore, 1/8 to 5/8 in. OD, 1 to 1 3/4 in. Length, 1 1/16 to 3 9/16 in.

Design Options: Three hub arrangements; both hubs inside center member, both hubs outside center member, or one hub inside and one hub outside center member. Coupling variations include special hubs, bores, and materials, as well as floating-shaft units for increased misalignment capacity.

Manufacturer: Thomas Flexible Coupling Co., Warren, Pa.

Tinymite

Form: Two brass hubs connected by nylon slider element. Pins which are mounted transversely across the face of each hub engage slots on the faces of slider. Slots in slider are displaced 90 deg from each other. Floating slider



construction permits relative sliding movement of hubs and slider.

Deflection Characteristics: Angular misalignment, 5 deg. Parallel misalignment, 1/16 in. Zero torsional flexibility.

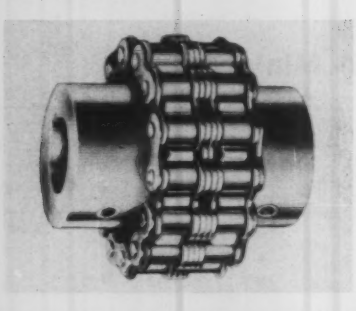
Sizes: Bore, 1/4 and 3/16 in. OD, 1/2 in. Length, 11/16 in.

Manufacturer: Renbrandt Inc., Boston, Mass.

FLEXIBLE COUPLINGS

chain type

Acme Standard



Form: Two sprockets connected by standard A.S.A. double-width roller chain. Single, removable connecting pin permits quick assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.1 to 28 hp at 100 rpm. 17 to 421 hp at 1800 rpm.

Maximum Speed: 1800 to 5000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1/2 deg (approx). Parallel misalignment, 0.005 to 0.011 in. (approx). End play, 0.02 to 0.07 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, 7/16 to 4 5/8 in. OD, 2 13/32 to 9 1/8 in. Length, 2 17/32 to 6 31/32.

Design Options: Aluminum revolving cover. Taper hub bushings. Special bores.

Manufacturer: Acme Chain Corp., Holyoke, Mass.

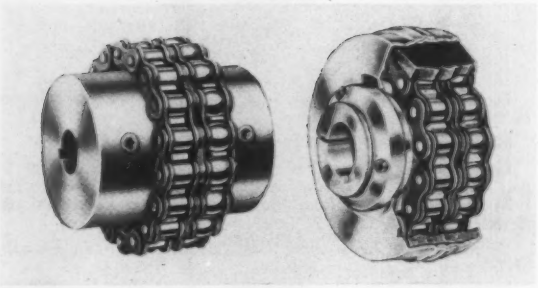
Acme Super

Form: Two sprockets connected by special double-width roller chain. One strand of chain has standard cylindrical rollers, other strand has special spherical rollers. Single, removable connecting pin permits quick assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.5 to 11 hp at 100 rpm. 15 to 95 hp at 1800 rpm.

Maximum Speed: 1800 to 3000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1 1/2 to



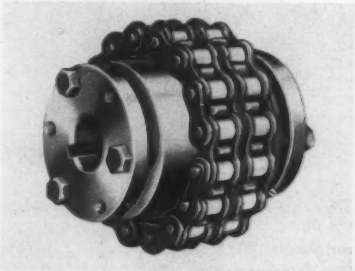
3 deg. Parallel misalignment, 0.010 to 0.017 in. End play, 0.08 to 0.30 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, 5/8 to 2 11/16 in. OD, 3 1/32 in. Length, 2 17/32 to 5 in.

Design Options: Aluminum cover. Tapered hub bushings. Special bores.

Manufacturer: Acme Chain Corp., Holyoke, Mass.

Browning C



Form: Two sprockets with hardened teeth connected by standard A.S.A. double roller chain. Detachable connecting links permit assembly or disassembly of chain. Requires periodic lubrication.

Capacity: 1.33 to 63 hp at 100 rpm. 15 to 341 hp at 1800 rpm.

Maximum Speed: 1800 to 3600 rpm, depending on size.

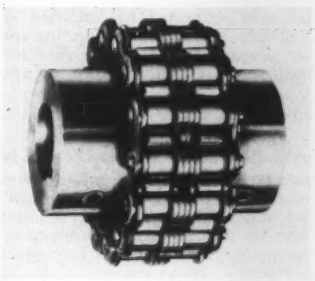
Deflection Characteristics: Limited angular and parallel misalignment. End play, 1/16 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, 3/8 to 3¾ in. OD, 2⅜ to 8⅜ in. Length, 2 11/16 to 7⅛ in.

Design Options: Steel fixed-bore type or pearlitic malleable bushed-type sprockets. Taper hub bushings. Sealed revolving covers.

Manufacturer: Browning Mfg. Co., Maysville, Ky.

Cullman Cylindrical Roller



Form: Two sprockets connected by standard double-strand roller chain. Detachable connecting links permit assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.1 to 28 hp at 100 rpm. 17 to 421 hp at 1800 rpm.

Maximum Speed: 1800 to 5000 rpm, depending on size.

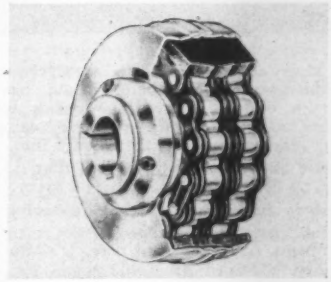
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 0.005 to 0.011 in. End play, 0.02 to 0.07 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, 7/16 to 4⅝ in. OD, 2 13/32 to 9⅛ in. Length, 2 17/32 to 6 31/32 in.

Design Options: Special bores. Taper hub bushings. Sealed aluminum revolving covers.

Manufacturer: Cullman Wheel Co., Chicago, Ill.

Cullman Cylindrical-Convex Roller



Form: Two sprockets with taper hub bushings connected by special double-strand roller chain. One strand of chain (driving sprocket) has standard cylindrical rollers, other strand (driven sprocket) has special spherical rollers. Detachable connecting links permit assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Chain and sprocket teeth are enclosed by sealed aluminum cover. Requires periodic lubrication.

Capacity: 1.5 to 11 hp at 100 rpm. 15 to 95 hp at 1800 rpm.

Maximum Speed: 1800 to 3000 rpm.

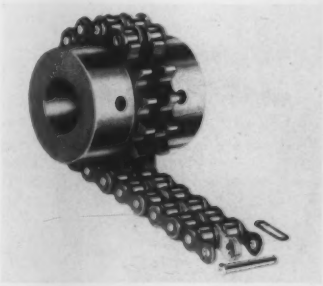
Deflection Characteristics: Angular misalignment, 1½ to 3 deg. Parallel misalignment, 0.010 to 0.017 in. End play, 0.08 to 0.30 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, ⅜ to 2 in. OD, 3 1/32 to 6 1/32 in. Length, 2 19/32 to 4 5/64 in.

Design Options: Fixed-bore types.

Manufacturer: Cullman Wheel Co., Chicago, Ill.

Diamond



Form: Two hardened steel sprockets connected by standard A.S.A. double-strand roller chain. Single, removable connecting pin permits quick assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.8 to 120 hp at 100 rpm. 12 to 725 hp at 1200 rpm.

Maximum Speed: 1200 to 5000 rpm, depending on size.

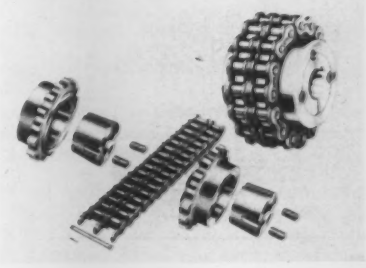
Deflection Characteristics: Angular misalignment, 1 to 2 deg. Parallel misalignment, 0.008 to 0.016 in. (approx). End play, 0.08 to 0.20 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, ½ to 6⅛ in. OD, 2 13/32 to 11 29/32 in. Length, 2 17/32 to 8⅞ in.

Design Options: Taper hub bushings. Special hubs and coupling sizes. Sealed aluminum revolving covers.

Manufacturer: Diamond Chain Co. Inc., Indianapolis, Ind.

Dodge Chain



Form: Two oversize sprockets with taper bushings connected by standard A.S.A. double-width roller chain. Single, removable connecting pin permits quick assembly or disassembly of chain. Sprockets have two more teeth than conventional designs. Steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 3.6 to 40 hp at 100 rpm. 18 to 141 hp at 1800 rpm.

Maximum Speed: 2000 to 5000 rpm, depending on size.

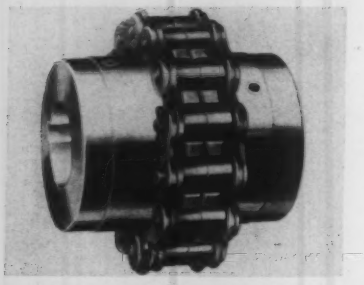
Deflection Characteristics: Angular misalignment, 1 deg (approx). Parallel misalignment, 0.010 to 0.020 in. (approx). End play, 0.02 to 0.06 in. (approx). Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, ½ to 3 in. OD, 3 1/32 to 7⅜ in. Length, 1 15/16 to 4½ in.

Design Options: Floating-shaft type couplings. Modified

taper-bushing designs. Sealed aluminum revolving covers, **Manufacturer:** Dodge Mfg. Corp., Mishawaka, Ind.

Link-Belt RC



Form: Two sprockets connected by a special single-strand roller chain. Rollers are divided to provide independent contact action with each sprocket. Detachable link permits assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.48 to 200 hp at 100 rpm. 10 to 1032 hp at 700 rpm.

Maximum Speed: 700 to 5000 rpm, depending on size.

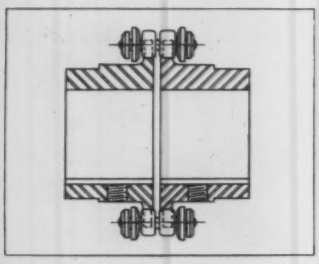
Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 1/64 in. End play, ⅛ to ¼ in. Limited torsional flexibility, governed by deflection and spring action of chain and sprocket teeth.

Sizes: Bore, ½ to 12 in. OD, 2 19/32 to 19 15/16 in. Length, 2 7/16 to 12⅜ in.

Design Options: Sealed metal or plastic revolving covers, or stationary steel housing.

Manufacturer: Link-Belt Co., Chicago, Ill.

Medart Chain



Form: Two sprockets connected by a special single-strand roller chain. Rollers are divided to provide independent contact action with each sprocket. Detachable link permits assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.45 to 90.6 hp at 100 rpm. 19.3 to 924 hp at 1500 rpm.

Maximum Speed: 1500 to 5000 rpm, depending on size.

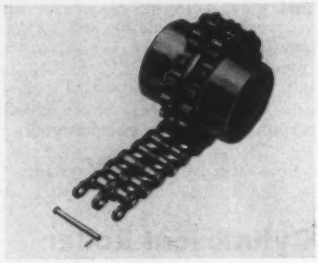
Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 1/64 in. End play, 1/16 to ⅜ in. Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, ½ to 7⅛ in. OD, 2 19/32 to 14⅝ in. Length, 2 5/16 to 9⅜ in.

Design Options: Special bores and hubs. Larger coupling sizes. Sealed revolving type steel covers.

Manufacturer: The Medart Engineering and Equipment Co., St. Louis, Mo.

Morse DRC



Form: Two sprockets connected by Standard A.S.A. double-roller chain. Single, removable connecting pin permits quick assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 2.7 to 97 hp at 100 rpm. 14.5 to 286 hp at 1800 rpm.

Maximum Speed: 1800 to 5000 rpm, depending on size.

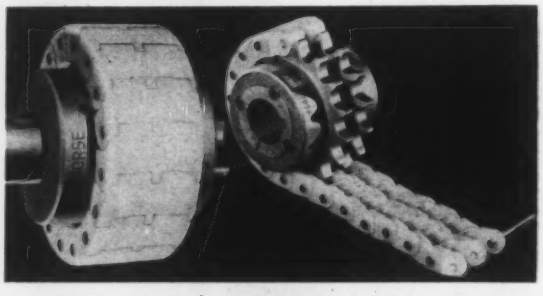
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 2 per cent of chain pitch (0.010 to 0.030 in.) End play, 3/32 to 3/16 in. Limited torsional flexibility, governed by yielding and spring action of chain.

Sizes: Bore, ⅜ to 4⅛ in. OD, 2 13/32 to 9 1/16 in. Length, 2 9/16 to 7⅜ in.

Design Options: Special bores, hubs, and coupling sizes. Sealed steel or plastic revolving covers. Modified couplings include floating-shaft and double (tandem) types.

Manufacturer: Morse Chain Co., Ithaca, N. Y.

Morse Nylon



Form: Two stock steel roller-chain sprockets connected by special single-strand nylon chain. Chain has smooth outer surface with divided inner link pockets which engage the sprocket teeth. Removable stainless steel pins permit assembly or disassembly of chain at any link.

Capacity: Static torque rating below 100 rpm, 37.8 to 336 lb-ft. 0.72 to 6.4 hp at 100 rpm. 3.92 to 34.8 hp at 1800 rpm.

Maximum Speed: 2500 to 5000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 0.010 in. End play, 3/32 in. Limited torsional flexibility, governed by yielding and spring action of chain.

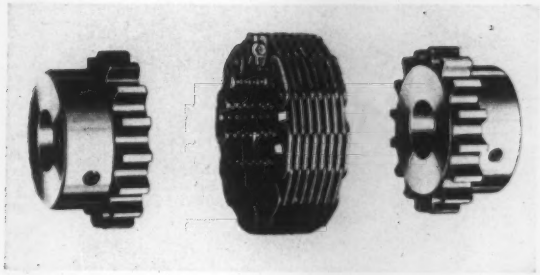
Sizes: Bore, ½ to 1¾ in. OD, 2.06 to 5.23 in. Length, 2 1/32 to 2 9/32 in.

Design Options: Special bores. Taper hub bushings.

Manufacturer: Morse Chain Co., Ithaca, N. Y.

Morse Silent

Form: Two sprockets wrapped with silent chain. Offset guide link, which fits in groove in one sprocket acts to position the chain in relation to one coupling hub. Single, removable connecting pin permits rapid assembly or disassembly of the chain. All-steel construction with hardened



sprocket teeth. Requires periodic lubrication.

Capacity: 6.0 to 320 hp at 100 rpm. 15 to 770 hp at 700 rpm.

Maximum Speed: 700 to 5000 rpm, depending on size.

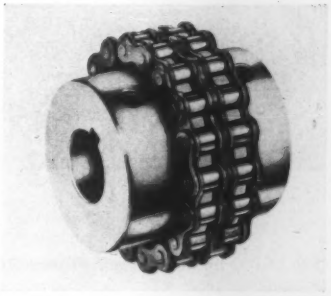
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 2 per cent of chain pitch (0.010 to 0.030 in.). End play, ¼ to 1 in. Limited torsional flexibility, governed by yielding and spring action of chain.

Sizes: Bore, ½ to 6⅜ in. OD, 3 1/16 to 13 1/16 in. Length, 4 9/16 to 12 3/16 in.

Design Options: Special bores and hubs. Special light-duty designs provide capacities down to 2.7 hp at 100 rpm. Sealed aluminum revolving covers. Modified couplings include floating-shaft and double (tandem) types.

Manufacturer: Morse Chain Co., Ithaca, N. Y.

Rex



Form: Two sprockets of special tooth form connected by a double-strand roller chain. Single, removable connecting pin permits quick assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1/6 to 97 hp at 100 rpm 13.7 to 670 hp at 1200 rpm.

Maximum Speed: 1300 to 5000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 0.008 to 0.034 in. End play, 1/16 to 5/16 in. Limited torsional flexibility, governed by yielding and spring action of chain operating over sprocket teeth.

Sizes: Bore, ½ to 5 in. OD, 2 17/32 to 12⅛ in. Length, 2 3/16 to 8⅜ in.

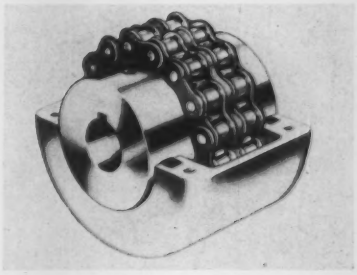
Design Options: Aluminum or plastic rotating covers. Coupling variations include shear-pin type and compound or dummy shaft arrangements for increased misalignment capacity.

Manufacturer: Chain Belt Co., Milwaukee, Wis.

Union Chain Roller

Form: Two sprockets connected by a strand of double-width roller chain. Single, removable connecting pin permits quick assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 0.9 to 200 hp at 100 rpm. 6.15 to 1032 hp at 700 rpm.



Maximum Speed: 700 to 5000 rpm, depending on size.

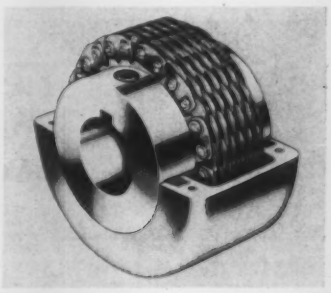
Deflection Characteristics: (approx) Angular misalignment, 2 deg. Parallel misalignment, 0.006 to 0.040 in. End play, 1/16 to ¼ in. Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, ½ to 10½ in. OD, 2 13/32 to 19 15/16 in. Length, 2 17/32 to 15 31/32.

Design Options: Sealed aluminum revolving covers.

Manufacturer: Union Chain and Mfg. Co., Sandusky, Ohio.

Union Chain Silent



Form: Two sprockets connected by a strand of silent chain. Chain is kept in place on sprockets by special side-bar links. Single, removable connecting pin permits rapid assembly or disassembly of the chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 1.9 to 279 hp at 100 rpm. 17 to 3080 hp at 1800 rpm.

Maximum Speed: 1800 to 5000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 2 deg. (approx). Parallel misalignment, 0.008 to 0.025 in. (approx). End play, ⅛ in. Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, ⅜ to 8 in. OD, 2⅛ to 14¾ in. Length, 2¼ to 11 in.

Design Options: Sealed aluminum revolving covers.

Manufacturer: Union Chain and Mfg. Co., Sandusky, Ohio.

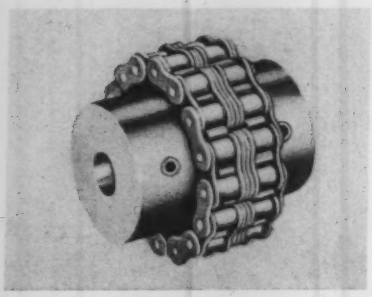
Union Gear SC

Form: Two sprockets connected by a strand of double-width roller chain. Detachable connecting links permit assembly or disassembly of chain. All-steel construction with hardened sprocket teeth. Requires periodic lubrication.

Capacity: 0.2 to 64 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1800 to 5000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, ½ deg (approx). Parallel misalignment, 0.006 to 0.030 in. End play, 1/16 to 3/16 in. Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.



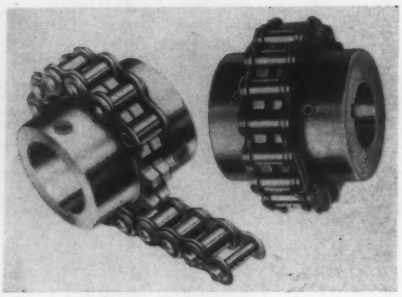
Sizes: Bore, 3/8 to 6 1/8 in. OD, 1 9/16 to 11 29/32 in. Length, 1 47/64 to 8 7/8 in.

Design Options: Special bores.

Manufacturer: Union Gear & Sprocket Corp., Quincy, Mass.

Whitney

Form: Two sprockets connected by a strand of single-roller chain. Detachable connecting link permits assembly or disassembly of chain. All-steel construction with hardened sprockets. Requires periodic lubrication.



Capacity: 0.9 to 84.8 hp at 100 rpm. 10.3 to 705 hp at 1200 rpm.

Maximum Speed: 1200 to 3600 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 2 per cent of chain pitch (0.010 to 0.040 in.). End play, 1/16 to 13/32 in. Limited torsional flexibility, governed by yielding and spring action of chain and sprocket teeth.

Sizes: Bore, 7/16 to 6 5/8 in. OD, 2 13/32 to 13 7/16 in. Length, 2 3/16 to 7 1/2 in.

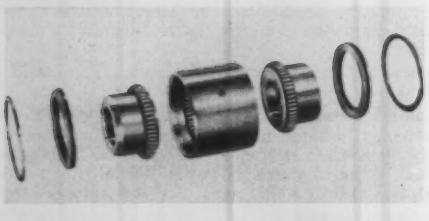
Design Options: Special bores, hubs or outside diameters. Sealed plastic or cast aluminum revolving covers, depending on size.

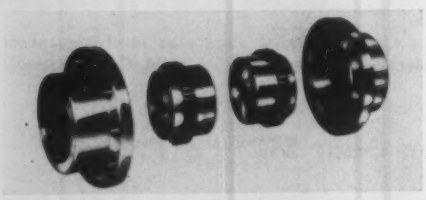
Manufacturer: Whitney Chain Co., Hartford, Conn.

FLEXIBLE COUPLINGS

gear type

Amerigear





Form: Two hubs with external gear teeth which engage internal teeth in one-piece sleeve or in each section of two-piece sleeve housing bolted together as a single unit. In heavy-duty units, end plates are bolted on to each cast steel housing section. External teeth are fully crowned (top and flanks) and chamfered at the tips; internal teeth are straight sided. Operating assembly is totally enclosed; one-piece sleeve design employs double O-ring sealing elements held in place by snap rings at each end of sleeve, two-piece housing has gasket between housing sections and O-ring seals at each end. All-steel construction. Requires periodic lubrication.

Capacity: 5 to 65,000 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 5 to 50,000 rpm, depending on type and size.

Deflection Characteristics: Angular misalignment, 3 deg. Parallel misalignment, 0.016 to 0.061 in. for one-piece sleeve, 0.041 to 0.260 in. for two-piece housing. End play, 1/4 to 1 in. Limited torsional flexibility, governed by deflection of gear teeth under load.

Sizes: Bore, 0 to 34 in. OD, 2 5/8 to 78 in. Length, 2 3/8 to 55 in.

Design Options: Special hubs and bores. Standard and heavy-duty units. Coupling variations include single-engagement, mill-motor, shear-pin, cut-out, vertical, axially adjustable, spacer, brake-drum, traction, continuous-lubricated, tandem, limited end float, and torsionally soft types. Modified designs with increased misalignment capacities.

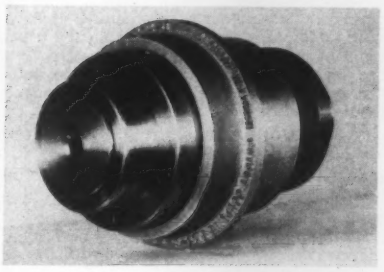
Manufacturer: Mechanical Power Transmission Div., Zurn Industries Inc., Erie, Pa.

Anchor-Waldron Cut-Out Coupling

Form: Gear-type coupling combined with overload-torque sensing mechanism. When torque at coupling exceeds predetermined value, outer sleeve moves axially to operate motor-circuit shut-off switch. Totally enclosed assembly is sealed. Torque-sensing mechanism resets automatically. Requires periodic lubrication.

Capacity: 0.024 to 4.15 hp at 100 rpm. (Torque ratings, 15 to 2600 lb-in.)

Maximum Speed: 2400 rpm.

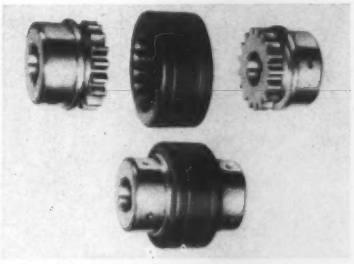


Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 0.025 in. End play, ¼ in. Limited torsional flexibility.

Sizes: Bore, ¾ to 2½ in. OD, 7⅛ to 8½ in. Length, 10⅜ to 11 13/16.

Manufacturer: John Waldron Corp., Subsidiary of Midland-Ross Corp., New Brunswick, N. J.

ASG



Form: Two alloy-steel hubs with external gear teeth which engage internal teeth in one-piece nonmetallic sleeve. Flange on hubs limits depth of engagement in sleeve. Gear teeth are straight sided; internal teeth run full length of sleeve.

Capacity: 0.02 to 2.78 hp at 100 rpm. Torque rating is constant at all operating speeds.

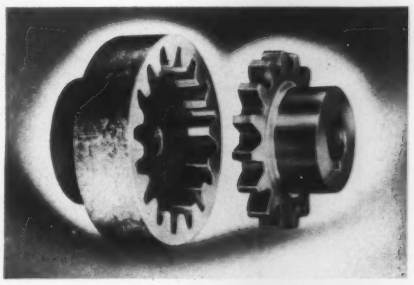
Maximum Speed: 5000 rpm.

Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 1/32 to 1/16 in. End play, ⅛ to 7/32 in. Limited torsional flexibility, governed by deflection of teeth under load.

Sizes: Bore, ¼ to 2½ in. OD, 1 3/16 to 5 in. Length, 1 21/32 to 6¼ in.

Manufacturer: American Stock Gear Div., Perfection Gear Co., Harvey, Ill.

CDF



Form: Steel pinion and mating internal gear of molded celoron plastic. Pinion teeth are completely enclosed in plastic coupling half when assembled.

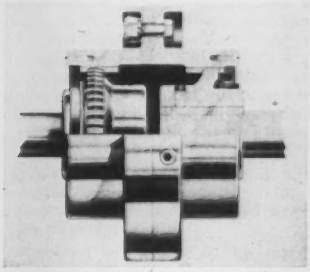
Capacity: 0.5 to 20 hp at 100 rpm. 2 to 77 hp at 1800 rpm.

Maximum Speed: 2500 to 6500 rpm, depending on size.

Sizes: Bore (max), ¾ to 2⅞ in. OD, 2 9/16 to 9½ in. Length, 2 5/16 to 8¾ in.

Manufacturer: Continental-Diamond Fibre Corp., a subsidiary of The Budd Co., Newark, Del.

Dihedral



Form: Two hubs with external gear teeth which engage internal teeth in each section of two-piece sleeve housing. Housing sections are bolted together as a single unit. Sides and top of external teeth are tapered from center; internal teeth are straight sided. Operating assembly is totally enclosed by means of lip type grease seals at ends of housing. Forged steel construction.

Capacity: 4 to 965 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 900 to 13,500 rpm, depending on size.

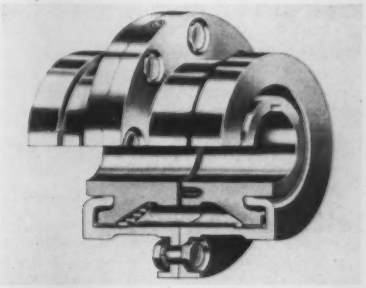
Deflection Characteristics: Angular misalignment, 3 to 12 deg. Parallel misalignment, 0.04 to 1 in. (approx.). End play, 3/16 to 1 1/16 in. Limited torsional flexibility, governed by deflection of teeth under load.

Sizes: Bore, ½ to 7¾ in. OD, 3½ to 20⅜ in. Length, 3 to 17 1/16 in.

Design Options: Special hubs and bores. Standard total angular misalignment capacities provided are 3, 7, and 12 deg. Special designs with higher misalignment capacities. Modified couplings include shear-pin, vertical, bolt-on, single-engagement, rigid-flange, sleeve, Jordan ,mill-motor, floating shaft, and spindle types.

Manufacturer: Ajax Flexible Coupling Co. Inc., Westfield, N. Y.

Fast's



Form: Two hubs with external splines which engage internal splines in each section of a two-piece sleeve housing. Housing sections are bolted together as a single unit. All spline teeth are straight sided. Operating assembly is totally enclosed by integral bearing rings positioned at the transverse centerline of the engaging teeth. Requires periodic lubrication. Forged-steel construction.

Capacity: 3.5 to 605 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 3600 to 14,500 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 0.017 to 0.105 in. End play, ¼ to ⅝ in. Limited torsional flexibility.

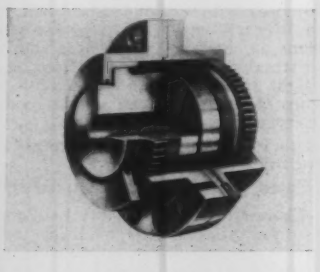
GEAR TYPE

Sizes: Bore, ½ to 6⅝ in. OD, 4 to 18 in. Length, 2⅝ to 14⅞ in.

Design Options: Special hubs and bores. Shrouded or exposed bolts on housing. Heavy-duty cast-steel units provide capacities up to 61,800 hp at 100 rpm with bores to 32 in. Modified couplings include mill-motor, continuous-lubricated, floating-shaft, oil-collector, single-engagement, high-speed, shear-pin, cooling-tower, cut-out, spindle, Jordan breaking-pin, slide, limited-space, marine, horizontal-thrust, vertical-thrust, vertical double-engagement, and disconnect types. Other variations include spacer elements, limited-end float modification, extra slide length, electrical insulation designs, extra misalignment capacity, and differential teeth arrangements.

Manufacturer: Koppers Co. Inc., Metal Products Div., Baltimore, Md.

Gearflex



Form: Two hubs with external gear teeth which engage internal teeth in each section of two or four piece housing. In large-size units, end plates are bolted on to each housing section. Housing sections are bolted together as single unit. External teeth are straight sided and crowned on top; internal teeth are straight sided without crown. Operating assembly is totally enclosed by means of ring packing at ends of housing. Cast or forged steel construction depending on size. Requires periodic lubrication.

Capacity: 23 to 19,000 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 400 to 4500 rpm, depending on size.

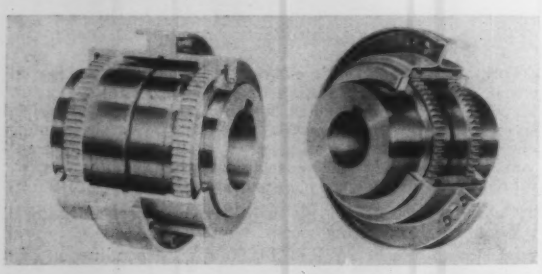
Deflection Characteristics: Angular misalignment, 1 deg (approx). Parallel misalignment, 0.028 to 0.318 in. End play, ¼ to 2 in. Limited torsional flexibility, governed by deflection of gear teeth under load.

Sizes: Bore, 1 to 21 in. OD, 7 15/16 to 55¼ in. Length, 5 to 49 in.

Design Options: Plain or safety type flanges on housing. Larger coupling sizes. Modified couplings include flange-mounted design for limited-space conditions, as well as single-engagement, floating-shaft, mill-motor, and shear-pin types.

Manufacturer: Farrel-Birmingham Co. Inc., Buffalo, N. Y.

Link-Belt Geared



Form: Two hubs with external gear teeth which engage internal teeth in one-piece sleeve or in each section of two-piece housing bolted together as a single unit. Gear teeth are straight sided; tops of external teeth are rounded at the ends. Operating assembly is totally enclosed; one-piece sleeve design has sealed two-piece cover, two-piece housing design has quad-ring hub seals at ends of housing. Steel construction. Requires periodic lubrication.

Capacity: 2.5 to 572 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1800 to 5000 rpm, depending on size; higher speeds permissible with balancing.

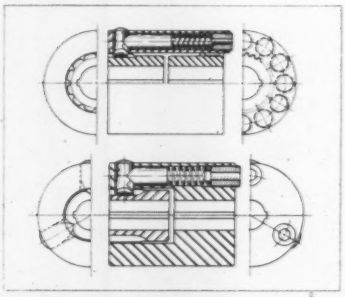
Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 1/32 to ⅛ in. End play, ¼ to ⅝ in. Limited torsional flexibility, governed by deflection of gear teeth under load.

Sizes: Bore, ½ to 7 in. OD, 3⅜ to 16⅛ in. Length, 2¾ to 12 11/16 in.

Design Options: Modified couplings include single engagement, mill-motor, spacer, and floating-shaft types. Press or push-fit bores.

Manufacturer: Link-Belt Co., Chicago, Ill.

Odin Disconnect



Form: Gear-type coupling combined with adjustable overload-torque release mechanism. When torque at coupling exceeds preset value, radial pistons engaging special cam surface on one hub are driven outward to disconnect position, completely disengaging coupling members. Piston action is controlled by an adjustable spring-detent mechanism which can be preset to vary the overload-release point or torsional flexibility of the coupling. Torque-release mechanism remains disengaged until reset. Larger coupling units employ two hubs connected by a sleeve which contains the torque-release mechanism. In the smaller units, sleeve is an integral part of one of the hubs. Requires periodic lubrication.

Capacity: Torque rating, 5 to 50,000 lb-in.

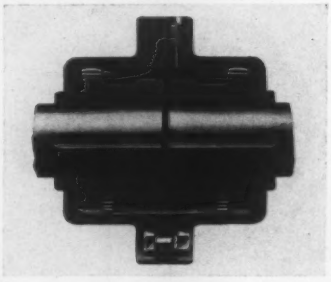
Maximum Speed: 2000 to 5000 rpm, depending on size.

Deflection Characteristics: Limited angular and parallel misalignment. End play, 1/16 to ⅛ in. Torsional flexibility, 2 deg.

Sizes: Bore, ⅛ to 4 in. OD, 1 to 12½ in. Length, 1 1/16 to 12 in.

Manufacturer: Odin Corp., Castleton, Ind.

Poole



Form: Two hubs with external gear teeth which engage internal teeth in each section of a two-piece sleeve housing. In heavy-duty units, end plates are bolted on to each housing section. Housing sections are bolted together as a single unit.

External teeth are straight sided and crowned; internal teeth are straight sided without crown. Operating assembly is totally enclosed by means of a gasket between housing section and composition packing ring at ends of housing. Requires periodic lubrication. All-steel construction.

Capacity: 2 to 54,000 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 200 to 13,800 rpm, depending on size.

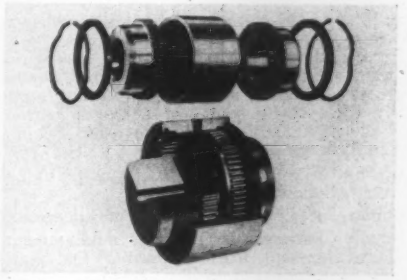
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment for couplings up to 5 in. nominal bore size, 1/32 to 5/32 in. (approx). End play, ¼ to 1 in. Limited torsional flexibility, governed by deflection of gear teeth under load.

Sizes: Bore, 7/16 to 33 in. OD, 3 7/16 to 77 in. Length, 1¾ to 57 in.

Design Options: Shrouded or through bolts on housing. Light, medium, standard, and heavy-duty units. Modified couplings include mill, mill-motor, floating shaft, single-engagement, spacer, disengaging, extended-disengaging, slide, Jordan, shear-bolt, shear-pin, vertical, vertical-extended, vertical single-engagement, and continuous-lubricating types.

Manufacturer: Poole Foundry & Machine Co., Baltimore, Md.

Sier-Bath



Form: Two hubs with external gear teeth which engage internal teeth in a one-piece sleeve. External teeth are straight sided and crowned; internal teeth are straight sided without crown and run full working length of sleeve. Operating assembly is totally enclosed by means of neoprene seals held in place by snap rings at each end of the sleeve. Forged steel construction. Requires periodic lubrication.

Capacity: 4 to 4000 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 2200 to 25,000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 0.032 in. End play, ¼ to ½ in. Limited torsional flexibility, governed by deflection of teeth under load.

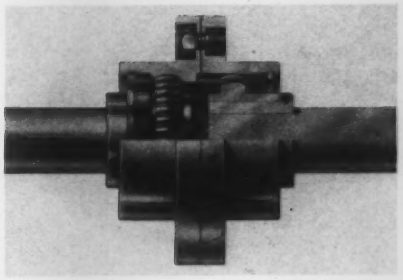
Sizes: Bore, ⅜ to 12½ in. OD, 3 5/16 to 20½ in. Length, 3⅛ to 25 in.

Design Options: Standard and heavy-duty units. Special hub, bore and oversize-coupling constructions. Modified couplings include mill-motor, vertical-shaft, horizontal floating-shaft, spacer, cut-out, shear-pin, vertical floating-shaft, sliding-hub, Jordan, brake-drum, insulated, aircraft, splined, continuous-lubrication, and flanged hub types.

Manufacturer: The Sier-Bath Gear and Pump Co. Inc., North Bergen, N. J.

Sphereflex

Form: Two hubs with external teeth which engage internal teeth in each section of a two-piece housing. Housing sections are bolted together as a single unit. External teeth are of special form with curved roots and spherical flanks; internal teeth are straight sided. Operating assembly is totally enclosed by means of neoprene seals held in place by snap rings at each end of the housing. Alloy-steel construction. Requires periodic lubrication.



Capacity: 2 to 610 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 3700 to 14,000 rpm, depending on size.

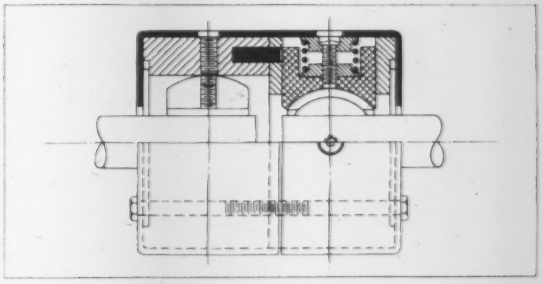
Deflection Characteristics: Angular misalignment, 7 deg. Parallel misalignment, 3/32 to 13/32 in. (approx). End play, ¼ to ¾ in. Zero torsional flexibility.

Sizes: Bore, ½ to 7 in. OD, 3 15/16 to 16⅝ in. Length, 3 to 14⅜ in.

Design Options: Special bores. Modified couplings include mill-motor, horizontal floating-shaft, spacer, vertical-mounted, vertical floating-shaft, and roll-shaft types.

Manufacturer: Philadelphia Gear Corp., Philadelphia, Pa.

Truax



Form: Two spherical-shaped hubs which engage radially mounted cylindrical shoes in each section of a two-piece housing. Housing sections are bolted together as a single unit. A curved lip or tooth on the surface of each hub fits into a mating curved slot on the bottom of each shoe which, in turn, is free to rotate about its own axis. Freedom of movement in two directions is provided by the design which permits the hub to be rocked back and forth in the slot or rotated about the shoe axis. Engagement of lip and slot is maintained under constant pressure by an adjustable spring element at the outer end of the shoe. Operating assembly is totally enclosed by a cover and nylon disc-seal assembly. Requires periodic lubrication.

Capacity: 1/40 to 3 hp at 100 rpm.

Maximum Speed: 1750 to 3450 rpm.

Deflection Characteristics: Angular misalignment, 15 deg. Parallel misalignment, 0.023 to 0.187 in. Zero end play and torsional flexibility.

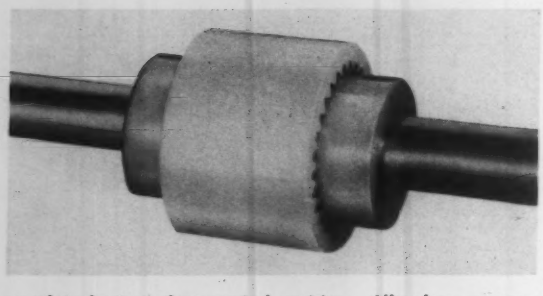
Sizes: Bore, ⅛ to 1½ in. OD, 17/32 to 5¾ in. Length ⅞ to 7 in.

Design Options: Metal or nylon housings.

Manufacturer: Olson Industrial Products Inc., Wakefield, Mass.

Waldron Jr.

Form: Two hubs with external teeth which engage internal teeth in a one-piece sleeve. Interior of sleeve is divided by a center shoulder which fits between the hubs and holds the sleeve in place. External teeth are curved at the top and the root; internal teeth are straight sided. Can be op-



erated in horizontal or vertical position. All-nylon construction.

Capacity: Static torque rating, 1100 lb-in. Operating torque rating, 100 lb-in.

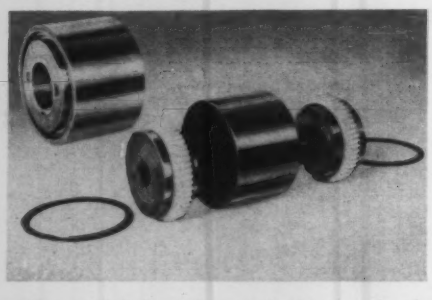
Maximum Speed: 10,000 rpm.

Deflection Characteristics: Angular misalignment, 3 deg. Parallel misalignment, 0.020 in. End play, 1/8 in. Limited torsional flexibility, governed by deflection of teeth under load.

Sizes: Bore, 3/8 to 3/4 in. OD, 1 15/16 in. Length, 2 9/32 in.

Manufacturer: John Waldron Corp., Subsidiary of Midland-Ross Corp., New Brunswick, N. J.

Waldron Series M



Form: Two steel hubs with taper bushings and nylon gear rings which engage internal teeth in a one-piece steel sleeve. External nylon teeth are curved at the top and the root; internal teeth are straight sided. Nylon gear rings are keyed to hubs and held in place by retaining rings. Sleeve is held in position on hubs by retaining rings at each end.

Capacity: 3½ hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 5000 rpm.

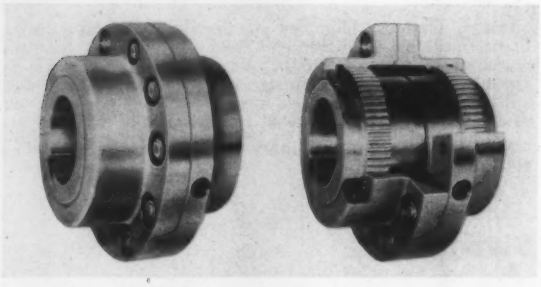
Deflection Characteristics: Angular misalignment, 3 deg. Parallel misalignment, 0.085 in. End play, 1/4 in. Limited torsional flexibility, governed by deflection of gear teeth under load.

Sizes: Bore, ½ to 1⅝ in. OD, 4 3/16 in. Length, 3⅛ in.

Design Options: Special bore and hub constructions. Modified couplings include vertical, floating-shaft and spacer types.

Manufacturer: John Waldron Corp., Subsidiary of Midland-Ross Corp., New Brunswick, N. J.

Waldron Standard



Form: Two hubs with external teeth which engage internal teeth in each section of a two-piece sleeve housing. Housing sections are bolted together as a single unit. External teeth are straight sided and crowned on top; internal teeth are straight sided without crown. Operating assembly is totally enclosed by means of a gasket between housing sections and a ring seal at ends of housing. Requires periodic lubrication. Forged-steel construction.

Capacity: 3.5 to 550 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 4000 to 12,000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 0.020 to 0.1 in. End play, 1/4 to 5/8 in. Limited torsional flexibility, governed by deflection of gear teeth under load.

Sizes: Bore, 15/16 to 6⅝ in. OD, 4 9/16 to 16 9/16 in. Length, 4 to 16 13/16 in.

Design Options: Shrouded or exposed housing bolts. Heavy duty mill-type units with bolted end plates on cast steel housing provide capacities to 4000 hp at 100 rpm and bores to 13 in. Modified couplings include mill-motor, floating-shaft, Jordan, shear-pin, cut-out, vertical, vertical floating-shaft, spacer, oil-collector, marine-gear, and high-speed types.

Manufacturer: John Waldron Corp., Subsidiary of Midland-Ross Corp., New Brunswick, N. J.

FLEXIBLE COUPLINGS

metallic flexible members

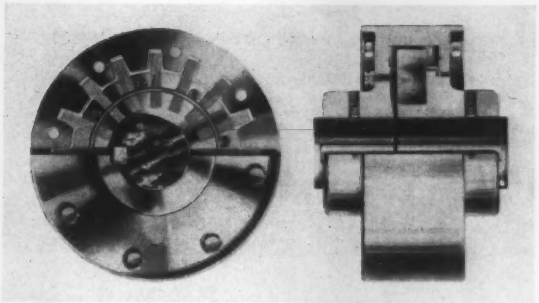
Brown Kushion-Torq

Form: Hub with radial laminated-spring spokes which engage mating internal slots in a drive ring mounted to flange of companion hub. Excessive deflection of springs under overload is prevented by two solid steel limit spokes. Resilience of assembly decreases with load; point of contact between spring spoke and tapered slot moves inward under load, decreasing "beam" length. Requires periodic lubrication. Operating assembly is totally enclosed by means of grease seal at overhanging flange rim.

Capacity: ½ to 1500 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 540 to 5500 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 0.030 in. End play, 3/16 to 1/4 in. Torsional flexibility, ½ deg.

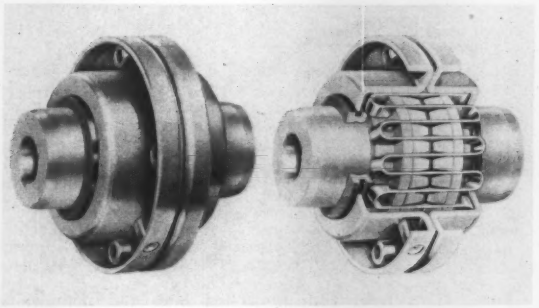


Sizes: Bore, ½ to 11 in. OD, 3 to 32 in. Length, 2 23/32 to 24¼ in.

Design Options: Oversize bores. Special hubs. Coupling variations include shear-pin and brake-drum types, and extended-length designs for increased end play.

Manufacturer: Brown Engineering Co., Reading, Pa.

Falk Steelflex



Form: Two-flanged hubs connected by a flat steel spring wound in the form of a grid. Rungs of grid member fit into specially shaped mating grooves in each flange. Flexibility of grid-groove assembly decreases with load; as load increases, point of contact of grid with groove wall moves toward face of flange, decreasing length of load-carrying "beam" span. Requires periodic lubrication. Operating assembly is totally enclosed by means of a sealed, two-piece cover which is bolted together as a single unit. All-steel construction. Operates in vertical or horizontal position.

Capacity: 0.6 to 13,000 hp at 100 rpm. 1.7 to 40,000 hp at 400 rpm.

Maximum Speed: 400 to 6000 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1 deg (approx). Parallel misalignment, ½ per cent of shaft diameter (approx). End play, ⅛ to ¾ in. Torsional flexibility, ¼ to 1¾ deg, depending on size.

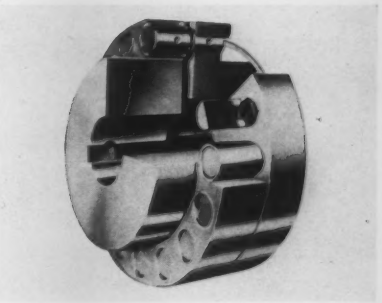
Sizes: Bore, ½ to 20½ in. OD, 3¾ to 71¾ in. Length, 3⅜ to 36½ in.

Design Options: Modified grid-groove construction for varying torsional-flexibility characteristics. Larger coupling sizes provide capacities up to 70,000 hp at 100 rpm. Coupling variations include two designs for limited-space application as well as high-speed, piloted, floating-shaft, brake-drum, controlled-torque, spacer, and tandem types.

Manufacturer: The Falk Corp., Milwaukee, Wis.

Francke

Form: Two alloy steel or semi-steel flanged hubs connected by laminated spring pins which are mounted in holes in the flanges. The pins consist of two slotted steel keepers, one on each end of the pin assembly, and a number of spring steel laminations which are free to swivel on cross pins mounted in the keeper slots. The pins are held in place in one flange by a retaining ring and are free to move axially in oil-impregnated bronze bushings in the mating flange.



Capacity: 2/3 to 3850 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 490 to 4000 rpm, depending on size.

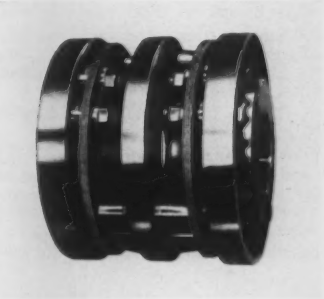
Deflection Characteristics: Angular misalignment, 1 to 1½ deg. Parallel misalignment, 0.010 to 0.100 in. End play, ½ in. Torsional flexibility, ¼ deg; varies with pin design.

Sizes: Bore, ½ to 13¼ in. OD, 3½ to 37 in. Length, 3½ to 28¼ in.

Design Options: Pins of varying flexibility. Special-purpose and heavy-duty units.

Manufacturer: John Waldron Corp., Subsidiary of Midland-Ross Corp., New Brunswick, N. J. (Smith & Serrill Flexpin Coupling with modified pin construction but otherwise identical with Francke design is also manufactured by John Waldron Corp.)

Thomas



Form: Two flanged metal hubs connected by special laminated disc rings which are bolted alternately to the flanges and a solid center ring by body-fitted bolts. Laminated rings consist of several thin spring steel rings assembled to alternate grain of material in adjacent rings.

Capacity: 0.11 to 3700 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 900 to 7000 rpm depending on size; higher speeds possible with balancing.

Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 1/64 to 5/64 in. End play, 1/32 to 7/32 in. Zero torsional flexibility.

Sizes: Bore, 5/16 to 13 in. OD, 2⅛ to 34⅜ in. Length, 2⅝ to 42 5/16 in.

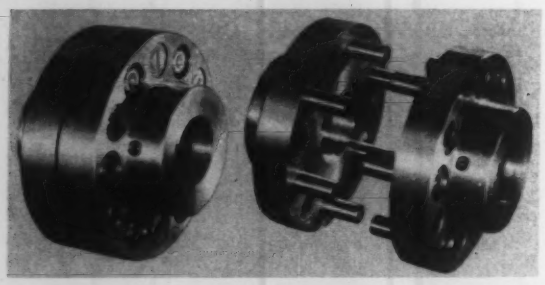
Design Options: Light, medium and heavy duty constructions; modified heavy-duty units provide capacities up to 40,000 hp at 100 rpm. Single-disc types for horizontal or vertical operation can support high radial loads and are suitable for use on single-bearing motor drives. Other coupling variations include special hub and bore constructions as well as spacer, floating-shaft, semi floating-shaft, flange-mounted, high-speed, sandwich (marine), and shear pin coupling types.

Manufacturer: Thomas Flexible Coupling Co., Warren, Pa.

FLEXIBLE COUPLINGS

nonmetallic flexible members

Ajax Rubber Cushioned



Form: Two flanged hubs connected by case-hardened, ground steel pins that are bolted alternately to each flange and fit into rubber-bushed graphited-bronze bearings in the opposite flange. Bearings are self-lubricating.

Capacity: 1.2 to 1700 hp at 100 rpm. Forged-steel units have momentary torque capacity of about 20 times rated value. Torque rating is constant at all operating speeds.

Maximum Speed: 840 to 8000 rpm, depending on size.

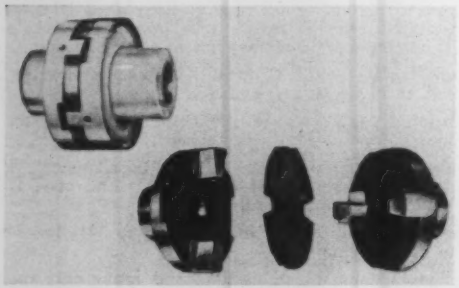
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 1 per cent of shaft diameter. End play, 1/16 to 1/4 in., depending on type and size. Torsional flexibility, 1/4 deg.

Sizes: Bore, 7/16 to 15 in. OD, 3 15/16 to 32 in. Length, 2 11/16 to 24 1/4 in.

Design Options: Standard flange constructions are forged carbon steel and cast semi-steel. Coupling variations include shear-pin, mill-motor, brake-drum, flywheel bolt-on, quick-disconnect, spacer, floating-shaft, and male-and-female types. Special materials, hubs, flanges, and bores.

Manufacturer: Ajax Flexible Coupling Co. Inc., Westfield, N. Y.

Bondflex



Form: Two flanged hubs connected by a floating leather disc. Two jaw projections on the face of each flange engage slots in the outer edge of the leather disc.

Capacity: 2 1/2 to 30 hp at 100 rpm. 8 3/4 to 105 hp at 1800 rpm.

Maximum Speed: 2500 to 6500 rpm, depending on size.

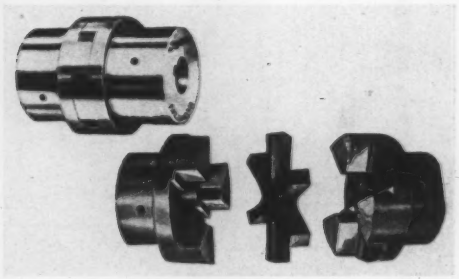
Deflection Characteristics: Angular misalignment, 2 to 5 deg. Parallel misalignment, 1/8 in. End play, 1/8 in. Minimum torsional flexibility.

Sizes: Bore, 3/8 in. to 2 5/8 in. OD, 3 1/8 to 8 1/16 in. Length, 3 3/8 to 8 13/16 in.

Design Options: Taper bores and oversize hubs.

Manufacturer: Charles Bond Co., Philadelphia, Pa.

Bondtru



Form: Two hubs with projecting jaws and nonmetallic spider insert. Arms of spider, which separate jaws, carry loads in compression. In operation, every other arm of insert carries load.

Capacity: 0.04 to 0.16 hp at 100 rpm. 1/2 to 200 hp at 1200 rpm.

Maximum Speed: 1380 to 8000 rpm, depending on size.

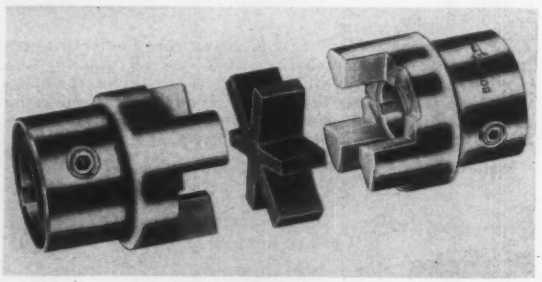
Deflection Characteristics: Angular misalignment, 2 to 3 deg. Parallel misalignment, 1/8 in. End play, 3/16 in. Torsional flexibility, 1 deg.

Sizes: Bore, 1/4 to 5 in. OD, 1 1/8 to 12 in. Length, 1 9/16 to 13 3/4 in.

Design Options: Taper bores. Modified hub constructions. Special lengths.

Manufacturer: Charles Bond Co., Philadelphia, Pa.

Boston FC



Form: Two steel hubs with projecting jaws and oil-resistant rubber or porous oil-impregnated bronze spider insert. Arms of spider, which separate jaws, carry loads in compression.

Capacity: Rubber-insert type, 0.10 to 4.4 hp at 100 rpm, 1.8 to 77.7 hp at 1750 rpm; bronze-insert type, 0.32 to 17.5

hp at 100 rpm, 3.6 to 201 hp at 1150 rpm.

Maximum Speed: 1150 to 3450 rpm, depending on type and size.

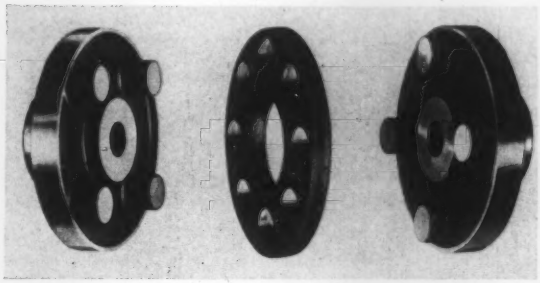
Deflection Characteristics: Limited angular and parallel misalignment. Certain amount of torsional flexibility with rubber insert, zero for bronze insert.

Sizes: Bore, 3/8 to 2 in. OD, 1 1/4 to 4 1/2 in. Length, 2 5/16 to 7 3/16 in.

Design Options: Special ball-bearing insert with hardened jaw construction for unrestricted end-play action.

Manufacturer: Boston Gear Works, Quincy, Mass.

Brown Buffer-Slot



Form: Two flanged hubs connected by a nonmetallic disc. Cylindrical lugs on the face of each hub flange fit into alternate holes in disc. Through slots between holes in disc permit compression of material between adjacent lugs when load is suddenly applied or shafts are misaligned.

Capacity: 0.75 to 65 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1300 to 6000 rpm, depending on size.

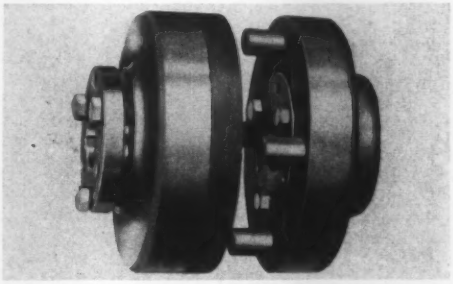
Deflection Characteristics: Angular misalignment, 2 deg (approx.) Parallel misalignment, 1/16 in. End play, 1/8 in. Torsional flexibility, 1/2 deg (approx).

Sizes: Bore, 1/2 to 4 in. OD, 3 to 14 in. Length, 3 1/4 to 10 1/8 in.

Design Options: Oversize hubs and bores. Brake-drum type coupling design.

Manufacturer: Brown Engineering Co., Reading, Pa.

Browning F



Form: Two flanged hubs connected by neoprene disc. Pin projections on face of each hub flange fit into alternate holes in disc.

Capacity: 0.04 to 10.60 hp at 100 rpm. 0.24 to 68.7 hp at 1800 rpm.

Maximum Speed: 2400 to 3600 rpm, depending on size.

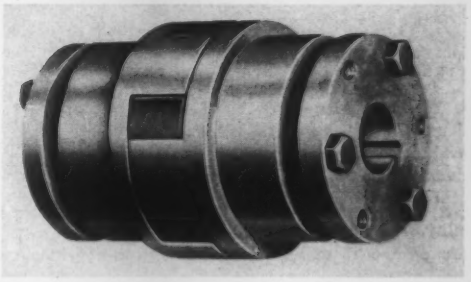
Deflection Characteristics: Limited angular and parallel misalignment. End play, 1/8 in. (approx). Torsional flexibility, 1/4 deg (approx).

Sizes: Bore, 1/4 to 3 3/4 in. OD, 1 3/4 to 8 3/8 in. Length, 1 1/2 to 6 15/16 in.

Design Options: Machined-steel or die-cast zinc-alloy fixed-bore type hubs, or malleable iron bushed type hubs. Taper hub bushings.

Manufacturer: Browning Mfg. Co., Maysville, Ky.

Browning J



Form: Two hubs with projecting jaws and neoprene spider insert. Arms of spider, which separate jaws, carry loads in compression.

Capacity: 0.14 to 7.4 hp at 100 rpm. 1 to 56.5 hp at 1800 rpm.

Maximum Speed: 3600 rpm.

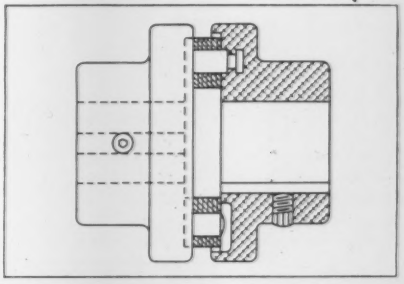
Deflection Characteristics: Limited angular and parallel misalignment. End play, 1/8 in. (approx). Torsional flexibility, 1/4 deg (approx).

Sizes: Bore, 3/8 to 2 11/16 in. OD, 1 1/16 to 4 11/16 in. Length, 1 21/32 to 6 3/16 in.

Design Options: Die-cast zinc-alloy or malleable iron fixed-bore type hubs, or malleable iron bushed type hubs. Taper hub bushings. Modified coupling has two inserts separated by center unit for increased flexibility or length.

Manufacturer: Browning Mfg. Co., Maysville, Ky.

Central



Form: Two flanged hubs connected by leather disc. Lug projections on face of each flange fit into alternate holes in disc.

Capacity: 1/6 to 15 hp at 1800 rpm.

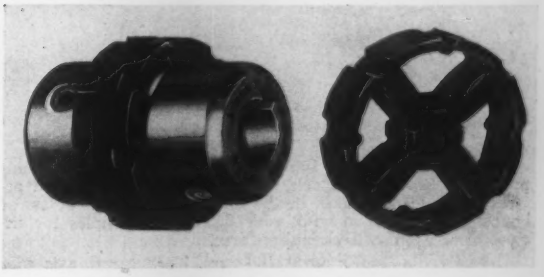
Maximum Speed: 1800 rpm.

Deflection Characteristics: Minimum angular and parallel misalignment, and torsional flexibility. End play, 1/16 to 1/8 in. (approx).

Sizes: Bore, 1/4 to 1 5/8 in. OD, 1 7/8 to 4 5/8 in. Length, 1 7/8 to 4 5/16 in.

Manufacturer: Central Die Casting & Mfg. Co., Inc., Chicago, Ill.

Certified



NONMETALLIC FLEXIBLE MEMBERS

Form: Two hubs with projecting curved jaws and cross-shaped neoprene insert. Inserts for heavy-duty types are reinforced by outer, imbedded steel ring. Arms of insert, which separate jaws, carry loads in compression.

Capacity: ¼ to 15 hp at 1750 rpm.

Maximum Speed: 1750 rpm.

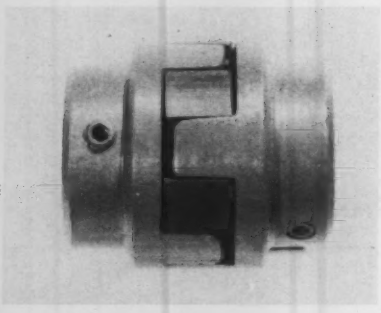
Deflection Characteristics: Angular misalignment, 2 to 3 deg (approx). Parallel misalignment, 0.010 to 0.015 in. (approx). End play, 0.010 to 0.015 in. approx). Torsional flexibility, 1 to 2 deg.

Sizes: Bore, 3/16 to 1⅝ in. OD, 1 1/16 to 4⅝ in. Length, 1 9/16 to 4⅜ in.

Design Options: Regular and heavy-duty units. Tandem coupling arrangement. Special coupling designs.

Manufacturer: Certified Flexible Couplings Inc., Mount Vernon, N. Y.

Climax C



Form: Two die-cast or cast-iron hubs with projecting jaws and molded-rubber spider insert. Arms of spider, which separate jaws, carry loads in compression. Insert is locked in position by tongue-and-groove design of spider arms and jaws.

Capacity: 1 to 12 hp at 1750 rpm.

Maximum Speed: 4000 to 5000 rpm.

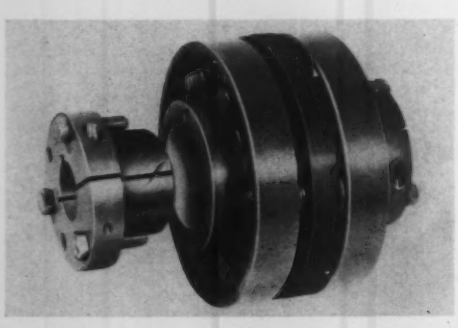
Deflection Characteristics: Angular misalignment, 3 deg. Parallel misalignment, 1/16 in. End play, ⅛ in. (approx). Torsional flexibility, ¼ deg (approx).

Sizes: Bore, ¼ to 1⅝ in. OD, 2 1/32 to 3 13/16 in. Length, 2 1/16 to 4⅜ in.

Design Options: Splined or taper bores. Special hubs.

Manufacturer: Climax Metal Products Co., Cleveland, Ohio.

Climax Knob-Disc



Form: Two cast iron flanged hubs bolted to a rubber-impregnated heavy-fabric disc. Bolts from each flange are attached to alternate holes in the disc. Semispherical bosses or knobs are molded integral with discs at bolt holes for increased strength and clamping force.

Capacity: 0.4 to 75 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 2000 to 5000 rpm, depending on size.

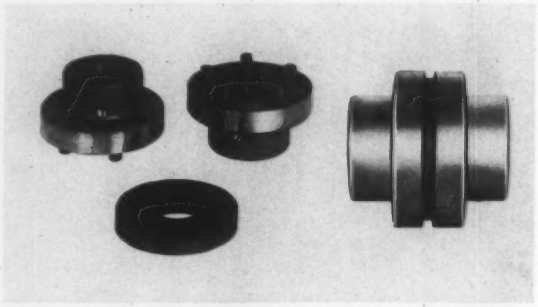
Deflection Characteristics: Angular misalignment, 3 deg. Parallel misalignment, 1/16 in. End play, 0.08 to 0.35 in. (approx). Minimum torsional flexibility.

Sizes: Bore, ½ to 5 in. OD, 3¼ to 14 3/16 in. Length, 2¾ to 13½ in.

Design Options: Splined or taper bores. Special hubs. Taper hub bushings. Modified design has protective flange rims removed. Other coupling variations include floating shaft, flange, shear-pin, and brake-drum types.

Manufacturer: Climax Metal Products Co., Cleveland, Ohio.

Congress



Form: Two flanged hubs connected by a reinforced rubber disc. Projecting pins on face of each flange fit into alternate holes in disc.

Capacity: ¼ to 25 hp at 1750 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1800 to 3600 rpm, depending on prime mover.

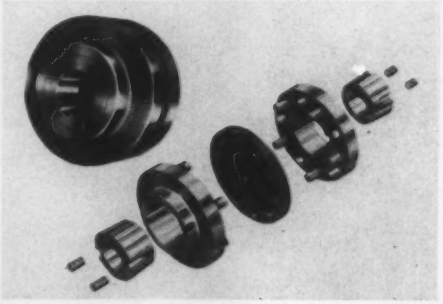
Deflection Characteristics: (approx) Angular misalignment, 2 deg. Parallel misalignment, 1/16 to ⅛ in. End play, ⅛ to ¼ in. Torsional flexibility, ½ deg.

Sizes: Bore, ⅜ to 2⅛ in. OD, 2 1/16 to 6 in. Length, 1⅞ to 6 in.

Design Options: Leather or Fabreeka discs.

Manufacturer: Congress Drives Div., Tann Corp., Detroit, Mich.

Dodge Flexible Disc



Form: Two flanged hubs with taper bushings connected by a neoprene bonded fabric disc. Projecting pins on the face of each flange engage alternate holes in the disc.

Capacity: 0.60 to 24.9 hp at 100 rpm. 3.61 to 149 hp at 1800 rpm.

Maximum Speed: 2000 to 3600 rpm, depending on size.

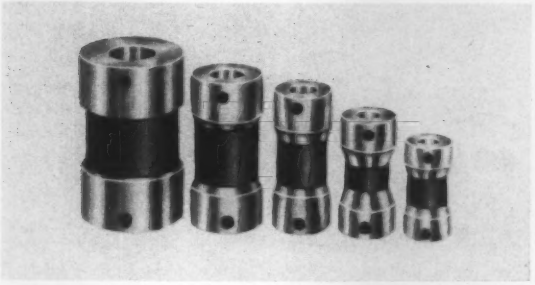
Deflection Characteristics: Limited angular and parallel misalignment, and torsional flexibility. End play, ⅛ to ¼ in.

Sizes: Bore, ½ to 3 in. OD, 3¼ to 10 in. Length, 2⅝ to 7½ in.

Design Options: Modified taper-bushing designs.

Manufacturer: Dodge Mfg. Corp., Mishawaka, Ind.

Dyna-Line



Form: Two metal hub fittings joined by a reinforced neoprene rubber tube section. Hub fittings are rolled on to ends of tube section to form a one-piece unit.

Capacity: 1/15 to 1½ hp at 1750 rpm.

Maximum Speed: 7600 rpm.

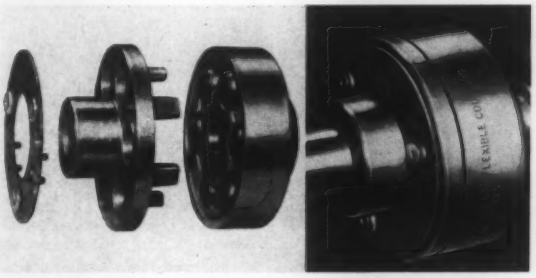
Deflection Characteristics: Angular misalignment, 5 to 10 deg (approx). Parallel misalignment, 1/32 to ⅛ in. (approx). Limited end play. Torsional flexibility, 30 deg.

Sizes: Bore, 3/16 to ¾ in. OD, 11/16 to 1 9/16 in. Length, 1 to 12 in.

Design Options: Special bores and hubs. Rubber tube sections of different materials and lengths.

Manufacturer: Guardian Products Corp., Michigan City, Ind.

Elliott C-W



Form: Flanged hub with lug projections that fit between neoprene or rubber balls mounted in pockets in companion flanged hub. In operation, lugs engage balls which carry loads in compression. Balls can be readily removed through oversize holes in the lug flange. A retaining plate, held in place by three screws covers the holes during operation. With the balls removed, the coupling will freewheel.

Capacity: 1 to 120 hp per 100 rpm. Torque rating is constant for all operating speeds above 200 rpm but can be increased 25 per cent for lower speeds.

Maximum Speed: 1200 to 3500 rpm, depending on size.

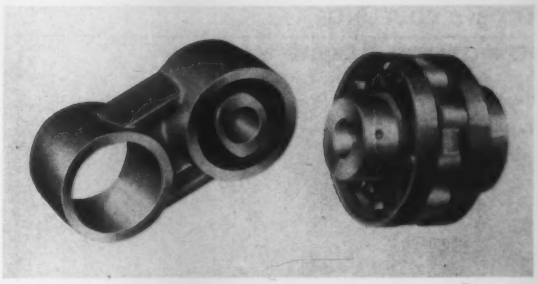
Deflection Characteristics: Angular misalignment, 0.2 deg (largest size) to 1 deg (smallest size). Parallel misalignment, 1/16 in. (approx). End play, 1/16 in. Torsional flexibility, 1 deg (approx).

Sizes: Bore, ½ to 8 in. OD, 3⅞ to 21½ in. Length, 3 to 16 in.

Manufacturer: Elliott Co., Div. of Carrier Corp., Jeannette, Pa.

Fabco RP

Form: Two flanged hubs connected by steel pins that are bolted alternately to each flange and fit into rubber-bushed blocks in the ends of heat-treated aluminum-alloy links. Every link element engages two pins, one from each flange. Bearing surface of rubber-bushed blocks in links is machined to same radius as inside surface of link eye.



Capacity: 23 to 260 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1000 to 2400 rpm, depending on size.

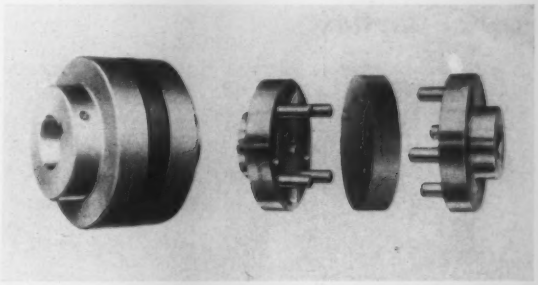
Deflection Characteristics: (approx) Angular misalignment, 1 to 2 deg. Parallel misalignment, 1/16 to ⅛ in. Limited end play. Torsional flexibility, ½ to 2 deg.

Sizes: Bore, 1⅛ to 7 in. OD, 8½ to 18¼ in. Length, 7 7/16 to 13 13/16 in.

Design Options: Larger coupling sizes. Special bores. Modified couplings include bolt-on and shear-pin types.

Manufacturer: F. A. B. Mfg. Co., Oakland, Calif.

Fabco SF



Form: Two flanged hubs connected by a laminated fabric and rubber molded disc. Projecting pins on face of each hub flange fit into alternate holes in disc.

Capacity: ½ hp at 1750 rpm for smallest size. 0.116 to 12.5 hp at 100 rpm for other sizes; torque rating is constant at all operating speeds.

Maximum Speed: 3600 to 10,000 rpm, depending on size.

Deflection Characteristics: (approx) Angular misalignment, 2 deg. Parallel misalignment, 1/16 to ⅛ in. End play, 1/32 to 5/16 in. Torsional flexibility, ¼ to 1 deg.

Sizes: Bore, ⅜ to 3 in. OD, 1 15/16 to 8 1/16 in. Length, 1 15/16 to 6 7/16 in.

Design Options: Special discs and bores. Modified couplings include bolt-on and shear-pin types.

Manufacturer: F. A. B. Mfg. Co. Inc., Oakland, Calif.

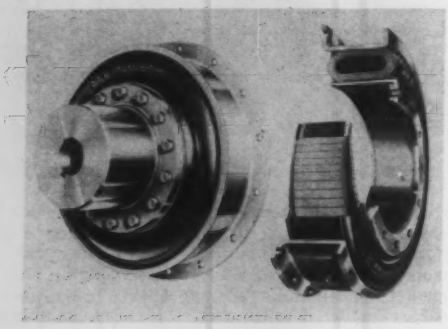
Falk Airflex

Form: Two steel rims bonded permanently to a tire-like rubber gland. Inner rim is bolted directly to flange on shaft or hub; outer rim has extended flange for bolting directly to flywheel or adapter plate. Gland is normally filled with glycerine solution under pressure. Elasticity of unit varies with gland pressure; as pressure is increased torsional rigidity is increased.

Capacity: 7.1 to 3560 hp at 100 rpm. 21.3 to 10,680 hp at 400 rpm.

Maximum Speed: 450 to 1800 rpm, depending on size; higher speeds possible with balancing.

Deflection Characteristics: Limited angular and parallel misalignment, and end play. Torsional flexibility, 1 to 2 deg



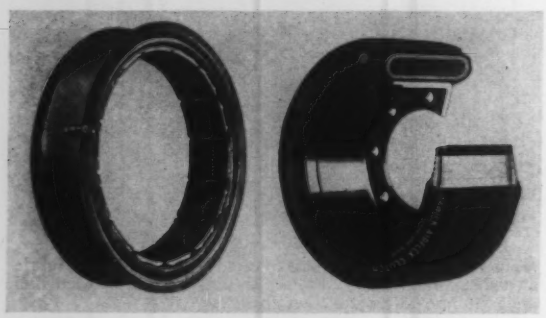
depending on gland pressure and size.

Sizes: Bore, ¾ to 13¼ in. OD, 10¼ to 53¾ in. (without adapter plate). Length, 3.312 to 12.000 in. with rims and gland only; 9⅜ to 36⅛ in. with two extended hubs.

Design Options: Various gland, hub, and adapter-plate arrangements for different mounting requirements. Special hubs and bores. Air-inflated glands. Modified couplings include floating shaft, tandem, and thrust types.

Manufacturer: The Falk Corp., Milwaukee, Wis.

Fawick Airflex



Form: Flanged rim with permanently attached rubber-and-cord tube or gland which expands outward when inflated with air to engage surface of a separate flanged drum on companion hub. Gland has rubber friction surface to provide maximum coefficient of friction. Engagement or disengagement of the coupling is accomplished at a standstill or at relatively low speed. Recommended operating air pressure is 75 psi; maximum recommended pressure is 110 psi. Torsional rigidity and torque capacity of coupling increases as gland pressure is increased.

Capacity: 2.5 to 133 hp at 75 psi air pressure and 100 rpm.

Maximum Speed: 800 to 3200 rpm, depending on size.

Deflection Characteristics: Limited angular misalignment and end play. Parallel misalignment, 0.015 to 0.030 in. depending on coupling size and air pressure. Torsional flexibility, ¼ to ½ deg depending on gland pressure.

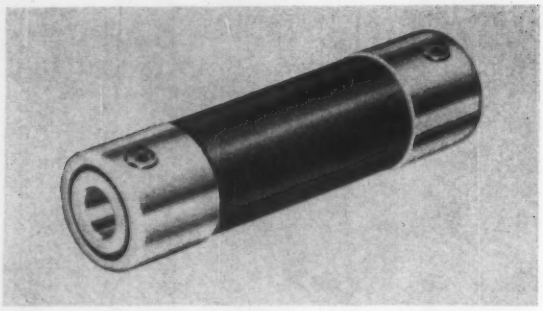
Sizes: Bore, ⅞ to 4¾ in. OD, 6¾ to 24¾ in. Length, 7 (approx) to 19⅛ in.

Design Options: Constricting type unit with internal flanged drum. Various mounting arrangements. Molded asbestos friction lining. Special hubs, drums, and bores.

Manufacturer: Fawick Airflex Div., Fawick Corp., Cleveland, Ohio.

Flexco

Form: Two machined, floating type hub bushings connected by a tubular neoprene body in a one-piece molded



construction.

Capacity: ⅛ to ¼ hp at 1725 rpm. 1/6 hp unit has 100 per cent continuous overload capacity.

Maximum Speed: 3450 rpm.

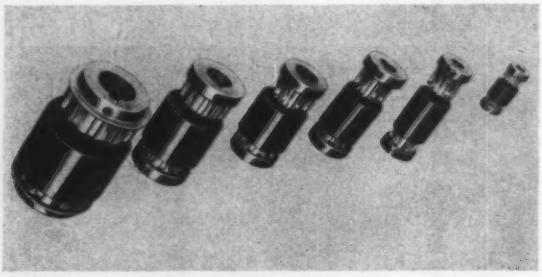
Deflection Characteristics: Angular misalignment, 5 to 7 deg. Parallel misalignment, ⅛ in. Torsional flexibility, 25 to 30 deg.

Sizes: Bore, 5/16 to ½ in. OD, 1⅛ in. Length, 2 to 6 in.

Design Options: Special nylon end fittings and coupling lengths. Rubber bodies of varying composition and hardness. Modified coupling design has special end socket for blind slip-on assembly with mating jaw hub.

Manufacturer: Flexible Coupling Mfg. Co., Chicago, Ill.

Gear-Grip



Form: Neoprene rubber tube section with removable nylon and metal hub fittings at each end. Hub fittings have external teeth which engage mating internal teeth on the inside surface of tube section. Under severe overload, tube section expands, permitting hub fittings to revolve. For longer coupling lengths, a rigid tubular insert is employed to prevent collapse of rubber section.

Capacity: 1/25 to 100 hp at 1750 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 7200 rpm.

Deflection Characteristics: Angular misalignment, 5 to 10 deg (approx). Parallel misalignment, 1/32 to ⅛ in. (approx). End play, 1/16 to ⅛ in. (approx). Torsional flexibility, 30 deg.

Sizes: Bore, ⅛ to 1⅞ in. OD, 0.4 to 3 7/16 in. Length, 0.74 to 6 in. without tubular insert.

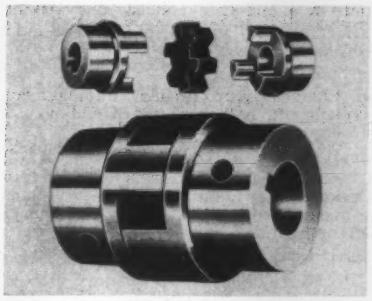
Design Options: Special bores and hubs. Rubber tube sections of different materials and lengths.

Manufacturer: Guardian Products Corp., Michigan City, Ind.

Gerbing

Form: Two hubs with projecting jaws and nonmetallic spider insert. Arms of spider, which separate jaws, carry loads in compression. In operation, every other arm of insert carries load.

Capacity: 1.5 to 675 hp at 1800 rpm.



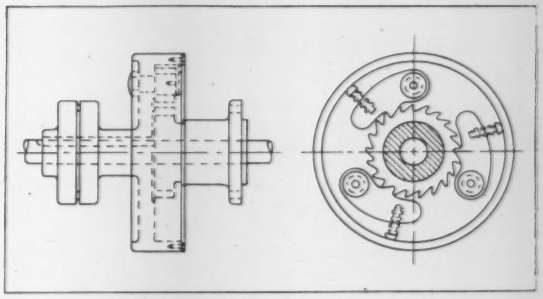
Maximum Speed: 1800 to 3600 rpm, depending on size.

Deflection Characteristics: (Approx) Angular misalignment, ½ to 2 deg. Parallel misalignment, 0.01 to 0.025 in. End play, ⅛ to ¼ in. Torsional flexibility, ½ to 1 deg.

Sizes: Bore, ⅜ to 5½ in. OD, 1¾ to 12 11/16 in. Length, 2 5/16 to 9⅜ in.

Design Options: Special hub and insert materials. Special hubs and bores.

Manufacturer: Gerbing Mfg. Corp., Northbrook, Ill.



Maximum Speed: 900 to 1800 rpm, depending on size.

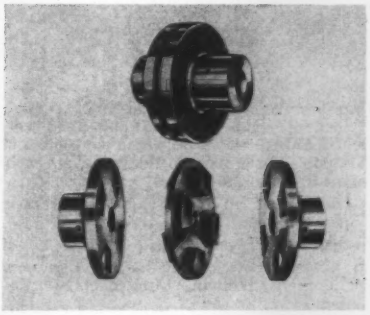
Deflection Characteristics: Angular misalignment, ½ deg (approx). Parallel misalignment, 1 per cent of shaft diam (approx). End play, ⅛ in. Torsional flexibility, ¼ deg.

Sizes: Bore, ¾ to 6½ in. OD, 7⅛ to 18¼ in. Length, 8 to 19⅛ in.

Design Options: Special ratchet-flange constructions for mounting to speed-reducer housings.

Manufacturer: D. O. James Gear Mfg. Co., Chicago, Ill.

Grundy



Form: Two flanged hubs, connected by an oil-resistant nonmetallic disc. Lugs on each face of disc fit into mating recesses in the face of each hub flange. Firm engagement of flanges with intermediate disc must be maintained.

Capacity: ¾ to 500 hp at 100 rpm. 1½ to 1000 hp at 600 rpm.

Maximum Speed: 675 to 6500 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 3 to 4 deg. Zero parallel misalignment. End play, ⅛ in. Torsional flexibility, ½ deg.

Sizes: Bore, 5/16 to 11 in. OD, 3 to 30 in. Length, 3 to 20⅞ in.

Design Options: Taper bores. Oversize hubs. Modified disc is designed to give way under jam loads for overload protection.

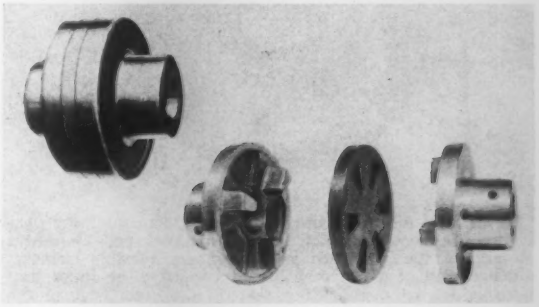
Manufacturer: Charles Bond Co., Philadelphia, Pa.

D. O. James Backstop

Form: Rubber-bumper type flexible coupling combined with ratchet-and-pawl mechanism. Coupling has two flanged hubs connected by rubber-bushed pins. One hub is mounted to motor shaft. Companion hub, which is mounted to speed reducer shaft, has integral drum-shaped housing which contains pawl elements. Nonrotating ratchet wheel is mounted on flanged sleeve bolted to speed-reducer housing. In operation, centrifugal force keeps pawls and ratchet wheels disengaged. When motor is stopped, pawls engage ratchet to prevent reverse rotation of driven equipment. Requires periodic lubrication.

Capacity: 1.6 to 170.0 hp at 200 rpm. 5.1 to 540 hp at 900 rpm.

Link-Belt Nonmetallic Disc-Lug



Form: Two cast-iron flanged hubs connected by a nonmetallic disc. Projecting lugs on face of each flange fit into alternate, mating openings in disc.

Capacity: 0.5 to 21 hp at 100 rpm. Torque rating is constant at all operating speeds.

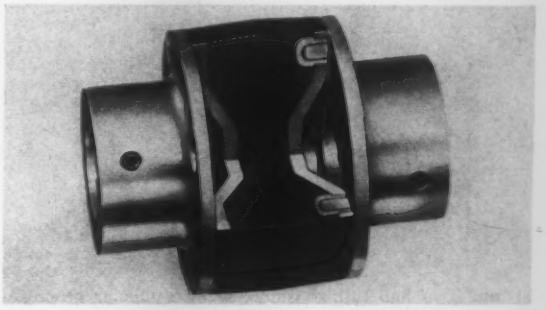
Maximum Speed: 3600 rpm.

Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 1/64 in. End play, ⅛ in. Limited torsional flexibility.

Sizes: Bore, ½ to 3⅜ in. OD, 3 to 10 in. Length, 3¾ to 7⅞ in.

Manufacturer: Link-Belt Co., Chicago, Ill.

Lord Constant Stress



Form: Two cast semi-steel flanged hubs connected by flexible rubber element fastened to face of each flange. Flexible element, which consists of solid neoprene core bonded to two steel plates, is removable in all but smallest size unit.

Capacity: 0.11 to 0.86 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 5500 to 7500 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 1/32 in. Limited end play. Torsional flexibility, 15 deg.

Sizes: Bore, 0 to 1.063 in. OD, 2.38 to 4.88 in. Length, 3 to 6 in.

Design Options: Special bores, hubs and rubber elements.

Manufacturer: Lord Mfg. Co., Erie, Pa.

Lord Disc

Form: Steel disc hub with multiple sockets containing flexible rubber elements which are alternately bolted to flanges on each of the connected shaft members. Flexible elements which consist of a neoprene biscuit bonded to an inner steel bushing, are removable. Shoulders on the outer edge of the rubber biscuits assure positive and permanent positioning of the elements.

Capacity: 0.36 to 2.24 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 4000 rpm.

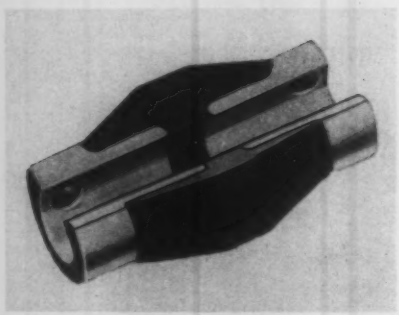
Deflection Characteristics: Angular misalignment, 2 to 3½ deg. Parallel misalignment, 1/32 in. End play, ±⅛ in.

Sizes: Bolt circle diameter, 2.62 to 4.31 in. OD, 4.12 to 7 in. Length, 1.06 to 2 in.

Design Options: Special disc designs.

Manufacturer: Lord Mfg. Co., Erie, Pa.

Lord Fhp



Form: Two hub fittings connected by a tubular neoprene rubber section in a one-piece bonded construction.

Capacity: 1/50 to 1 hp at 1750 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 10,000 rpm.

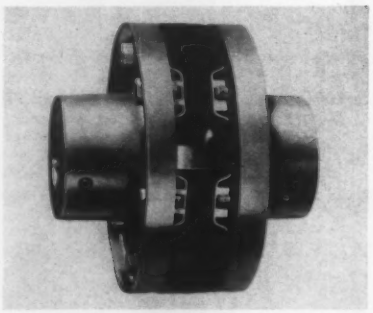
Deflection Characteristics: Angular misalignment, 2 deg. Parallel misalignment, 1/32 in. Limited end play. Torsional flexibility, 15 deg.

Sizes: Bore, 0.125 to 1 in. OD, 0.56 to 2.00 in. Length, 0.81 to 2.88 in.

Design Options: Monel, brass or alloy-steel hubs. Special bores, hubs, and rubber sections. Flexing elements of varying stiffness and composition.

Manufacturer: Lord Mfg. Co., Erie, Pa.

Lord Multiple Spool



Form: Two cast semi-steel flanged hubs connected by a number of flexible spool elements bolted to each flange. Spool elements consist of a neoprene core bonded to two steel plates. Spools have special locknuts at each end for bolt attachment to each flange.

Capacity: 1.14 to 5.72 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 4000 rpm.

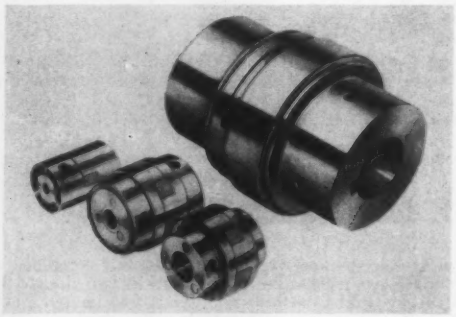
Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 1/32 in. Limited end play. Torsional flexibility, 2 deg.

Sizes: Bore, 0 to 3.25 in. OD, 8.88 to 11.88 in. Length 7.75 to 9.75 in.

Design Options: Special bores, hubs, and rubber spools.

Manufacturer: Lord Mfg. Co., Erie, Pa.

Lovejoy



Form: Two hubs with projecting jaws and nonmetallic load cushions in the form of either a one-piece Buna-N spider type insert or separate reinforced-neoprene inserts. Cushions, which separate jaws, carry loads in compression. In operation, load is carried by half of the cushions.

Capacity: 0.003 to 810 hp at 100 pm. 0.034 to 4250 hp at 1200 rpm.

Maximum Speed: 1200 to 3600 rpm, depending on size.

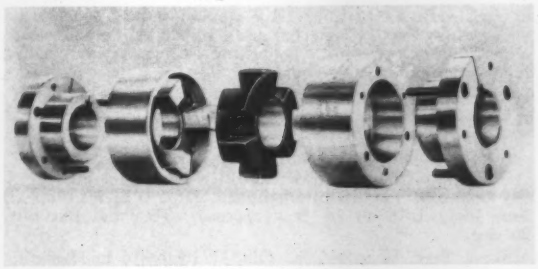
Deflection Characteristics: (approx) Angular misalignment, ½ to 1 deg. Parallel misalignment, 1/32 in. End play, ⅛ in. Torsional flexibility, 1 deg.

Sizes: Bore, ⅛ to 9½ in. OD, ⅝ to 21½ in. Length, ¾ to 21 3/16 in.

Design Options: Standard, medium-heavy, and heavy-duty designs. Aluminum, zinc, semi-steel, electric steel, or nodular iron hubs, depending on size. Special insert materials include leather, bakelite, heavy-duty brake lining compositions and others. Modified couplings include tandem-insert construction for increased flexibility or length; flange-mounted, disconnect, and brake drum types; and fan or blower design with special molded spider insert. Taper hub bushings. Special bore, hub, and insert dimensions.

Manufacturer: Lovejoy Flexible Coupling Co., Chicago, Ill.

Magnaloy



Form: Two magnesium-alloy flanged hubs with projecting jaws and enclosed neoprene spider-type insert. Arms of insert, which separate jaws, carry loads in compression and are connected by a thin section at the back of the jaw openings.

Capacity: 0.25 to 45.6 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 2000 to 8000 rpm.

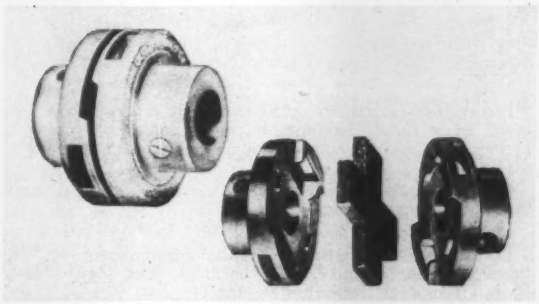
Deflection Characteristics: Limited angular and parallel misalignment. End play, 0.05 to 0.25 in. Torsional flexibility, ¼ deg (approx).

Sizes: Bore, ⅜ to 6 in. OD, 2.6 to 13.5 in. Length, 2.3 to 13.2 in.

Design Options: Interchangeable tapered hub.

Manufacturer: Detroit Power Coupling Co., Detroit, Mich.

Mather



Form: Two flanged hubs connected by a leather insert in the form of a cross. Insert is mounted to flanges by means of two radial slots, 180 degrees apart, in the rim of each flange.

Capacity: ¼ hp at 100 rpm, ⅞ hp at 1800 rpm.

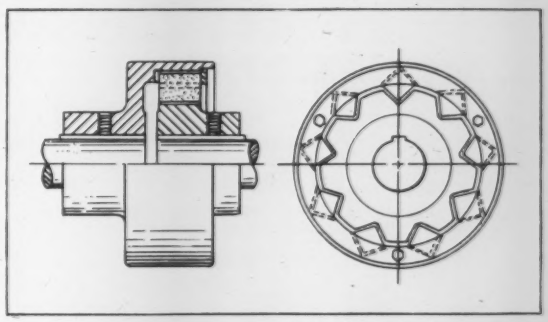
Maximum Speed: 8000 rpm.

Deflection Characteristics: Angular misalignment, 4 to 5 deg. Parallel misalignment, 3/16 in. End play, ⅛ in. Minimum torsional flexibility.

Sizes: Bore, 5/16 to ¾ in. OD, 2⅛ in. Length, 2 in.

Manufacturer: Charles Bond Co., Philadelphia, Pa.

Medart Flexible Pin



Form: Cast iron flanged hub with V-shaped external slots connected to companion cast iron flanged hub with mating internal slots by means of Textolite plastic pins. Externally slotted flange is completely enclosed within internally slotted hub when assembled. Pins, which have square cross section, fit into diamond shaped openings formed by mating slots in hubs and are held in place by a removable steel retaining ring bolted to the outer shell.

Capacity: 1.5 to 720 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 650 to 4800 rpm, depending on size.

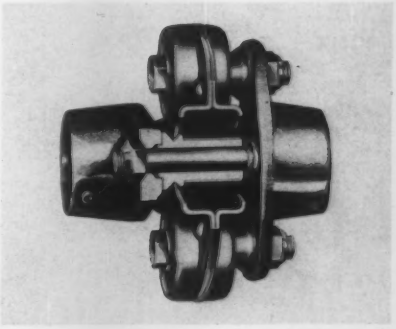
Deflection Characteristics: (approx) Angular misalignment, ½ deg. Parallel misalignment 1/32 in. End play, ⅛ to ⅜ in. Limited torsional flexibility.

Sizes: Bore, ½ to 10 in. OD, 4 to 30 in. Length, 3¼ to 21 ¾ in.

Design Options: Special pin materials and bores.

Manufacturer: Medart Engineering and Equipment Co., St. Louis, Mo.

Morflex



Form: Two flanged hubs which are bolted to alternate preloaded rubber biscuits in a center spider member. Biscuits, which are mounted in sockets in a two-piece stamping, consist of a reinforced neoprene doughnut with a metal-sleeve core. Machined bushings, pressed into the biscuits, are employed on all but the smallest sizes and have a pilot projection that fits into a counterbore on the hub flange.

Capacity: 0.06 to 21.1 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 4000 to 6000 rpm, depending on size.

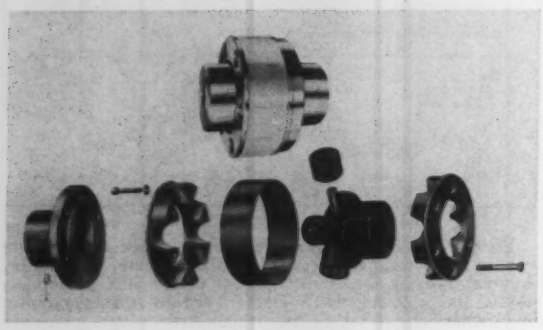
Deflection Characteristics: Angular misalignment, 1½ to 5 deg. Parallel misalignment, 1 per cent of shaft diameter. End play, 1/32 to ⅛ in. Torsional flexibility, 2 to 3½ deg.

Sizes: Bore, ¼ to 3½ in. OD, 2⅛ to 12 in. Length, 1¾ to 12½ in.

Design Options: Special hub, bore, and spider constructions. Pressed-steel safety covers. Standard coupling variation is double (tandem) design for extreme misalignment conditions. Special floating-shaft type arrangements.

Manufacturer: Morse Chain Co., Ithaca, N. Y.

Morflex Radial



Form: Hub with radially mounted reinforced neoprene biscuits which fit into mating sockets in a two-piece ring bolted to companion flanged hub. Cylindrical in shape, biscuits are pressed on to radial pins or trunnions on the hub. Operating assembly is totally enclosed by a sleeve cover.

Capacity: 3 to 262 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 4000 rpm.

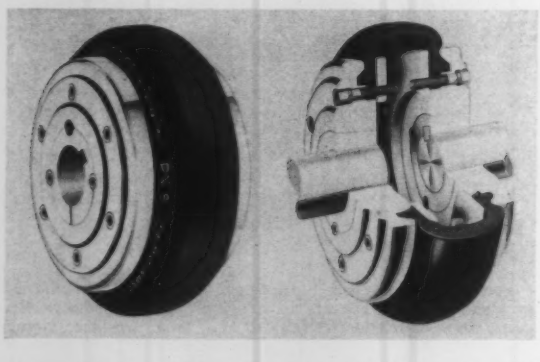
Deflection Characteristics: Angular misalignment, ½ deg. Limited parallel misalignment and end play. Torsional flexibility, 0.8 to 1.75 deg.

Sizes: Bore, ¾ to 8 in. OD, 4⅞ to 19 in. Length, 5 to 19 in.

Design Options: Special hubs and bores. Modified couplings include floating-shaft type and several flange-mounted designs for marine applications.

Manufacturer: Morse Chain Co., Ithaca, N. Y.

Para-Flex



Form: Two flanged hubs with taper bushings connected by a molded reinforced-rubber tire section. Tire is split laterally for assembly and disassembly, and is held in position by clamping rings bolted to each flange.

Capacity: 0.23 to 68.8 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1200 to 4500 rpm, depending on size.

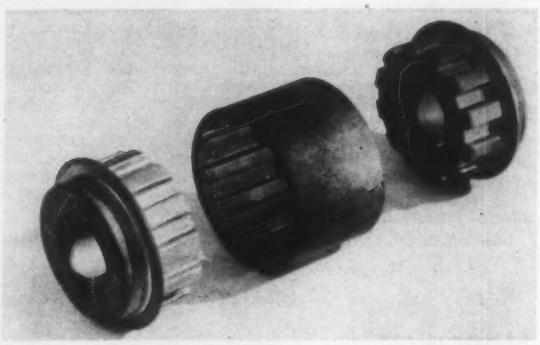
Deflection Characteristics: (largest size) Angular misalignment, 4 deg. Parallel misalignment, ⅛ in. End play, 5/16 in. Torsional flexibility, 5 deg (approx).

Sizes: Bore, ½ to 4½ in. OD, 5¼ to 21¾ in. Length, 2¾ to 11 15/16 in.

Design Options: Modified taper bushing designs. Special bores.

Manufacturer: Dodge Mfg. Corp., Mishawaka, Ind.

PowerGrip



Form: Neoprene sleeve with removable metal hub fittings at each end. Hub fittings have grooved surface which mates with axially molded internal teeth of sleeve. Under severe overload, sleeve expands, permitting fittings to revolve. For long coupling lengths, a rigid tubular insert is employed to prevent collapse of sleeve.

Capacity: 0.0048 to 2.28 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speeds: 7200 rpm.

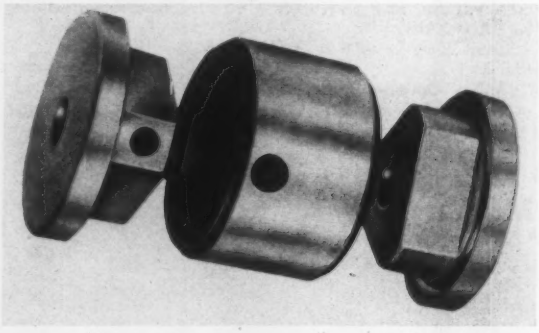
Deflection Characteristics: Angular misalignment, 5 to 10 deg (approx). Parallel misalignment, 1/32 to ⅛ in. (approx). End play, 1/16 to ⅛ in. (approx). Torsional flexibility, 30 deg.

Sizes: Bore, ⅛ to 1⅞ in. OD, 11/16 to 3⅞ in. Length, 1 to 3⅛ in. without sleeve insert; 3½ to 12 in. with insert.

Design Options: Special bores and hubs.

Manufacturer: Mechanical Goods Div., United States Rubber, New York, N. Y.

Smith & Serrell Flexring



Form: Two aluminum hubs which fit into a rubber core insert in a tubular aluminum center section. Opening in rubber core and mating section of hub are triangular in shape.

Capacity: 0.28 to 4.66 hp at 1000 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 3600 rpm.

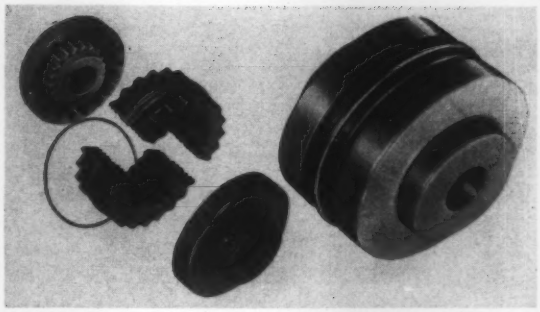
Deflection Characteristics: Angular misalignment, 1½ deg. Parallel misalignment, 0.010 to 0.030 in. End play, 1/16 to ⅛ in. Torsional flexibility, ½ deg.

Sizes: Bore, ⅛ to 1¼ in. OD, ⅞ to 2½ in. Length, 1⅛ to 2 5/16 in.

Manufacturer: John Waldron Corp., Subsidiary of Midland-Ross Corp., New Brunswick, N. J.

Sure-Flex

Form: Two cast iron flanged hubs connected by a two-piece rubber sleeve. External and internal teeth at each



end of the sleeve halves fit into mating teeth on the face of each flange. Sleeve halves are locked together in assembly by a sawtooth-joint construction.

Capacity: 0.09 to 11.4 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 1900 to 9200 rpm, depending on size; higher speeds possible with balancing.

Deflection Characteristics: Angular misalignment, 1 deg. Parallel misalignment, 1/32 to 1/16 in. End play, 1/16 to 1/8 in. (approx). Torsional flexibility, 15 deg.

Sizes: Bore, 3/8 to 2 7/8 in. OD, 2.094 to 10 in. Length, 2 1/8 to 8 1/4 in.

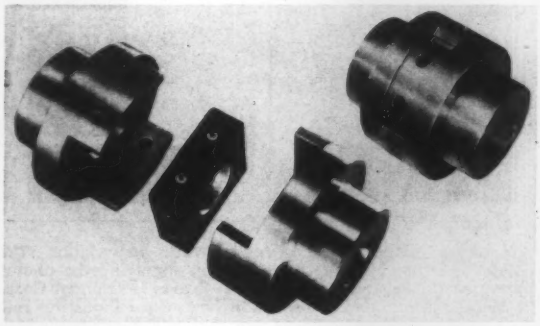
Design Options: High-speed coupling types.

Manufacturer: T. B. Wood's Sons Co., Chambersburg, Pa.

FLEXIBLE COUPLINGS

slider type

American



Form: Two forged steel or die-cast alloy flanged hubs connected by a square slider member. Each flange has two projecting C-shaped jaws which engage opposite sides of slider, permitting relative sliding motion of the two flanges at right angles to each other. Heavy-duty sliders are either self-lubricating metal blocks with loosely attached, replaceable bearing surfaces or oil-impregnated sintered metal. For self-lubricating types, which contain a lubricant reservoir that must be refilled periodically, bearing strips may be removed and replaced without disturbing the other coupling elements. Light duty sliders are made of a laminated plastic material which does not require lubrication.

Capacity: Up to 2480 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: Up to 6300 rpm, depending on size.

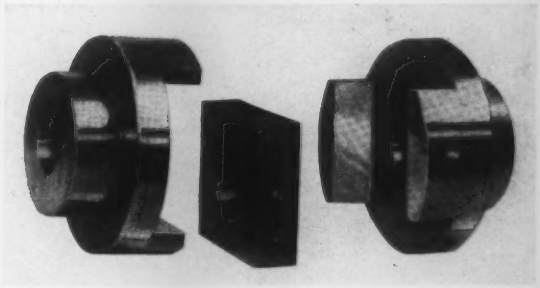
Deflection Characteristics: Angular misalignment, 1 1/2 deg. Parallel misalignment, 10 per cent of nominal shaft diameter. End play, 1/32 to 3/16 in. Zero torsional flexibility.

Sizes: Bore, 0 to 14 in. OD, 1 5/8 to 30 in. Length, 2 1/32 to 30 11/16 in.

Design Options: Light or heavy-duty units. Coupling variations include mill-motor, shear-pin, tandem, and brake-drum types.

Manufacturer: Mechanical Power Transmission Div., Zurn Industries Inc., Erie, Pa.

D. O. James Sliding Block



Form: Two nickel-iron flanged hubs connected by a square, nonmetallic slider member. Each flange has two projecting C-shaped jaws which engage opposite sides of slider, permitting relative sliding motion of the two flanges at right angles to each other. Slider is lubricated by self-contained oil reservoir that must be refilled periodically.

Capacity: 0.03 to 755 hp at 100 rpm. Torque rating is constant at all operating speeds.

Maximum Speed: 630 to 10,000 rpm, depending on size.

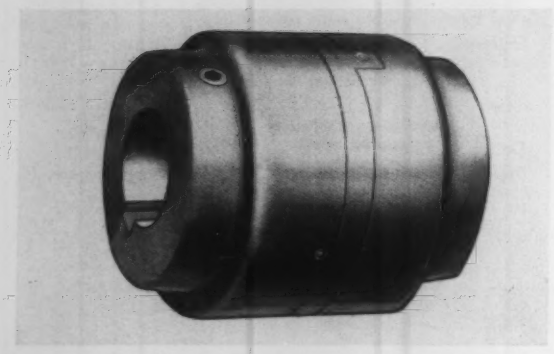
Deflection Characteristics: Angular misalignment, 3 deg. Parallel misalignment, 1 per cent of nominal shaft diameter. End play, 1/32 to 1 in. Zero torsional flexibility.

Sizes: Bore, 1/2 to 13 in. OD, 1 1/8 to 30 1/2 in. Length, 1 27/32 to 31 7/16 in.

Manufacturer: D. O. James Gear Mfg. Co., Chicago, Ill.

D. O. James Universal (Oldham)

Form: Two hubs connected by a center disc slider ele-



ment. Tongue projections across each face of the disc and displaced 90 deg from each other engage mating slots in the face of each hub. Floating disc construction permits relative sliding movement of flange and disc members. Requires periodic lubrication.

Capacity: 3.1 to 3100 hp at 100 rpm. Torque rating remains constant at all operating speeds.

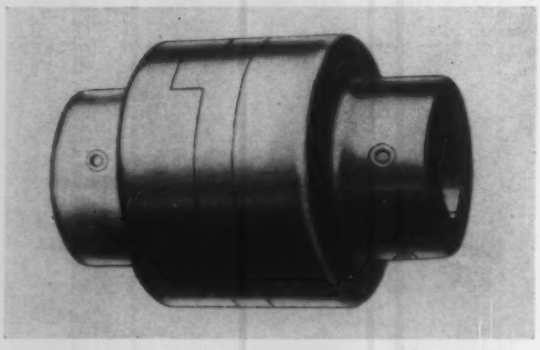
Maximum Speed: 85 to 770 rpm, depending on size.

Deflection Characteristics: Angular misalignment, 1 deg (approx). Parallel misalignment, 1 per cent of shaft diameter (approx). End play, 1/16 to 1 in. (approx). Zero torsional flexibility.

Sizes: Bore, ½ to 10 in. OD, 2½ to 22 in. Length, 2¾ to 24½ in.

Manufacturer: D. O. James Gear Mfg. Co., Chicago, Ill.

Link-Belt Oldham



Form: Two cast-iron flanged hubs connected by a steel disc slider element. Tongue projections across each face of the disc and displaced 90 deg from each other engage mating slots in the face of each flange. Floating disc construction permits relative sliding movement of flange and disc members. Requires periodic lubrication.

Capacity: 1.25 to 650 hp at 100 rpm. Torque rating is constant at all operating speeds.

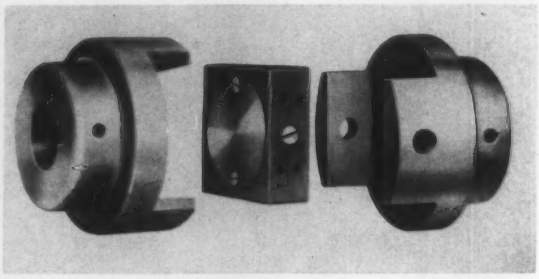
Maximum Speed: 100 rpm.

Deflection Characteristics: Angular misalignment, ½ deg. Parallel misalignment, 1/16 to ¼ in. End play, 3/32 to ½ in. Zero torsional flexibility.

Sizes: Bore, ½ to 8 in. OD, 3 to 24 in. Length, 3¾ to 30½ in.

Manufacturer: Link-Belt Co., Chicago, Ill.

Philadelphia Sliding Block



Form: Two flanged hubs connected by a square nonmetallic slider member. Each flange has two projecting C-shaped jaws which engage opposite sides of slider, permitting relative sliding motion of the two flanges at right angles to each other. Slider is lubricated by self-contained oil reservoir that must be refilled periodically.

Capacity: ¾ to 1000 hp at 100 rpm. Torque rating is constant at all operating speeds.

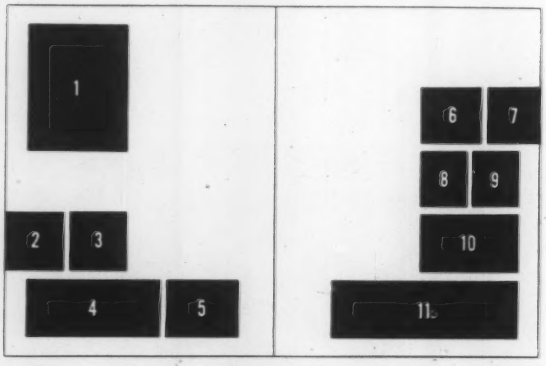
Maximum Speed: 750 to 8100 rpm, depending on size.

Deflection Characteristics: Angular misalignment, ¼ deg. Parallel misalignment, 10 per cent of nominal shaft diameter. End play, 3/32 to 1 in. Zero torsional flexibility.

Sizes: Bore, ½ to 13 in. OD, 3 to 30 in. Length, 3 9/16 to 30 11/16 in.

Manufacturer: Philadelphia Gear Works Inc., Philadelphia, Pa.

Acknowledgment



MACHINE DESIGN acknowledges with appreciation the courtesy of the following companies in supplying the photos appearing on Pages 102 and 103: 1. Reeves Instrument Corp. 2. Mechanical Power Transmission Div., Zurn Industries Inc. 3. Thomas Flexible Coupling Co. 4. Poole Foundry & Machine Co. 5. Elliott Co. 6. Farrel-Birmingham Co. Inc. 7. Falk Corp. 8. Congress Drives Div., Tann Corp. 9. Diamond Chain Co. Inc. 10. Lord Mfg. Co. 11. Whitney Chain Co.

Need Extra Copies?

Reprints of this 28-page design guide to flexible couplings are available for $1.00 each. Use the yellow post cards on page 19 for extra-copy orders.

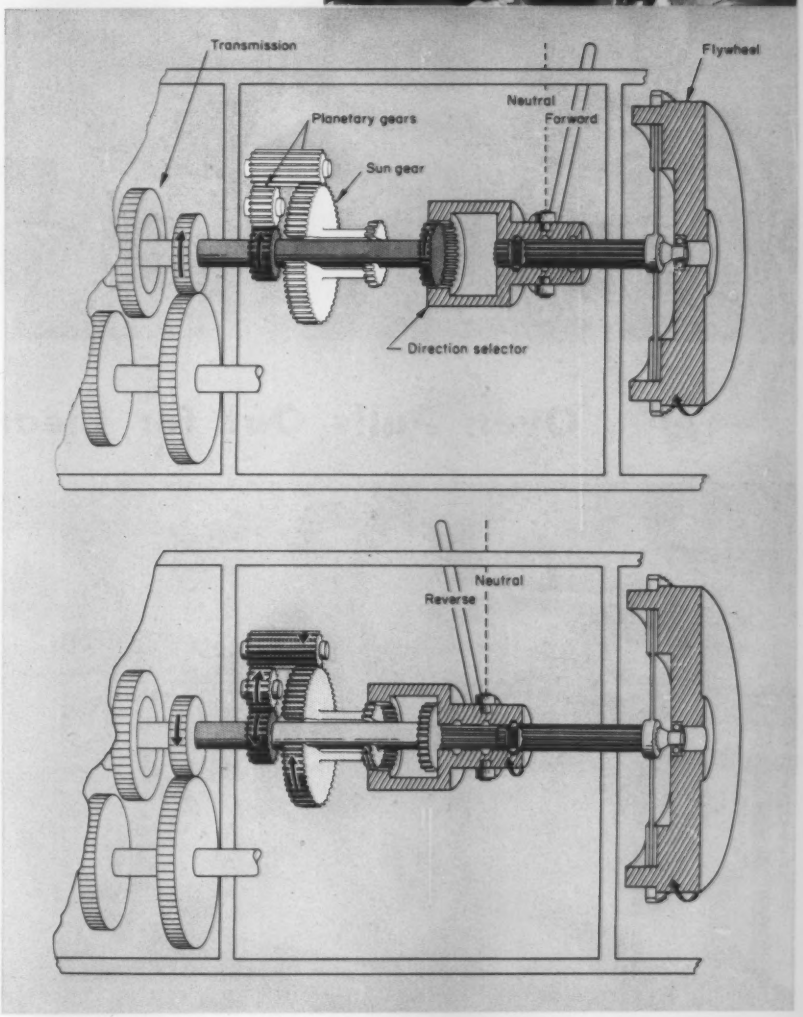
Gearshift Ahead of Transmission Quickly Reverses Any Forward Gear

FAST REVERSER unit located between engine flywheel and transmission permits operator to reverse in any forward gear. To change the reverser, the operator depresses the clutch pedal, pulls the reverser lever, and releases the clutch. Available on International Harvester 340 and 460 farm tractors, the fast-reverser attachment was designed for frequent forward-reverse operation, such as loader work with front-mounted scoops or forks.

Output speed of the reverser in the reverse position is 22 per cent faster than in the forward position.

IN FORWARD DRIVE, power from the flywheel goes directly to the transmission along the power shaft that passes through the sun gear. In forward operation, the planetary gears idle.

IN REVERSE OPERATION, the direction selector is meshed with the sun-gear drive gear instead of the power-shaft drive gear. The sun gear drives the planetary gears which reverse the power input to the transmission.



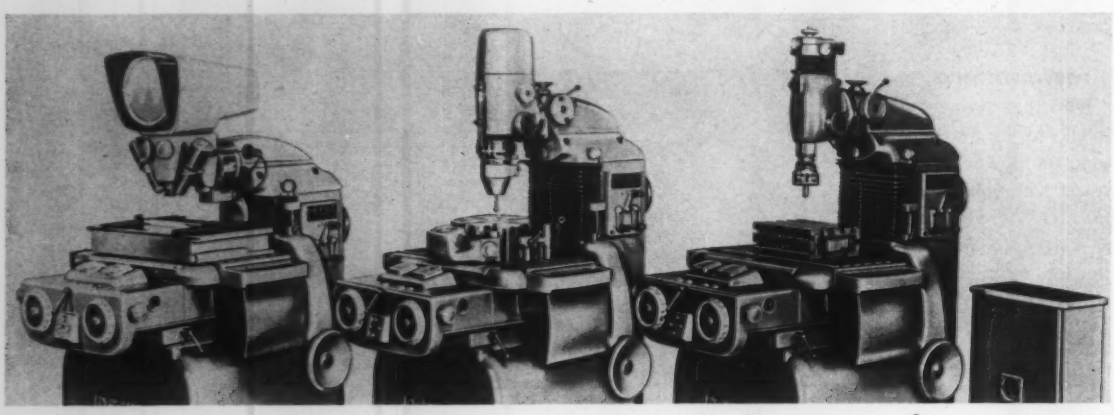
Interchangeable Heads Make Three Machines in One

QUICK-CHANGE ACT—from jig boring to jig grinding to optical-projection—is possible with a new Deckel machine tool. Interchangeable heads for these three functions are designed to fit a common base, and changing from one head to another takes only a matter of minutes.

The spindle of the jig borer operates at 20 speeds from 40 to 3150 rpm and 6 feed rates, either up or down.

On the jig grinder, the spindle has 12 planetary-motion speeds from 40 to 500 rpm and infinitely variable grinding speeds from 15,000 to 60,000 rpm.

Optical-projection table measurements can be read directly to 1/10,000 in. The stationary transverse scale is mounted on the machine base, and the movable longitudinal scale on the worktable slide. Two projection screens, one for each scale, are mounted on the cross slide. The worktable is adjusted until the projected index line of the desired setting is centralized in the proper light gap on the screen.



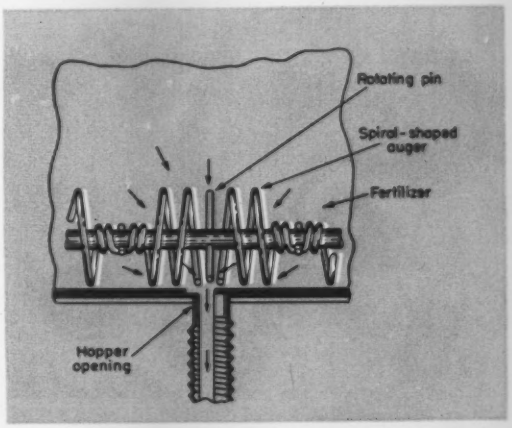
Oven Pulls Out for Cleaning

REMOVABLE OVEN in new electric range makes cleaning fast and easy. Before cleaning, the entire oven is pulled out like a drawer and set on the drop-down door. A door built in the top section of the oven lifts out, permitting cleaning of oven interior. The range is built by Frigidaire.

Spiral-Shaped Wires Move Fine Material

FLEXIBLE WIRE AGITATORS, used to auger fertilizer over hopper openings in a new Allis-Chalmers drill, minimize breakage from foreign objects. Made of tempered steel, each spiral-shaped spring member is center mounted. Each end of the spiral auger consists of two complete turns of wire, one end wound in a righthand direction and the other lefthand.

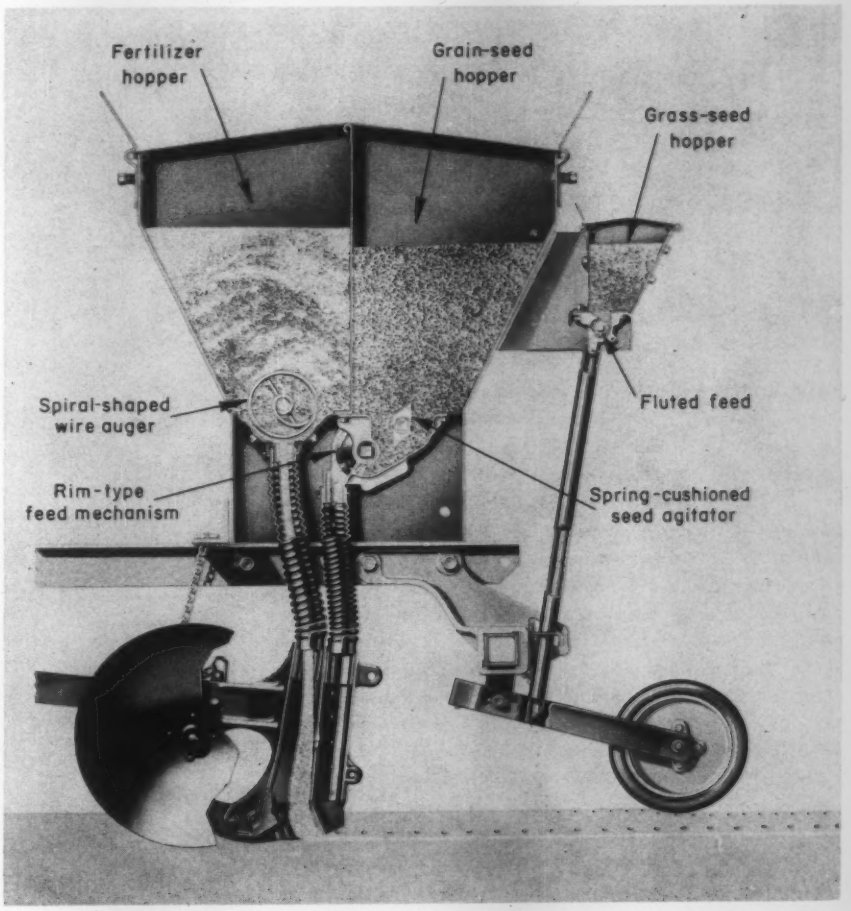
Each agitator is held in place by a short pin pushed through the driveshaft. Longer pins, passing through the driveshaft, clear fertilizer openings. The complete agitator assembly is easily removed for cleaning.



ADJUSTABLE RIM-TYPE FEED mechanism for each opening in the seed hopper offers high accuracy of seed spacing and prevents clogging. The seed-feed parts are made of press-formed metal and the feed case of die-cast aluminum.

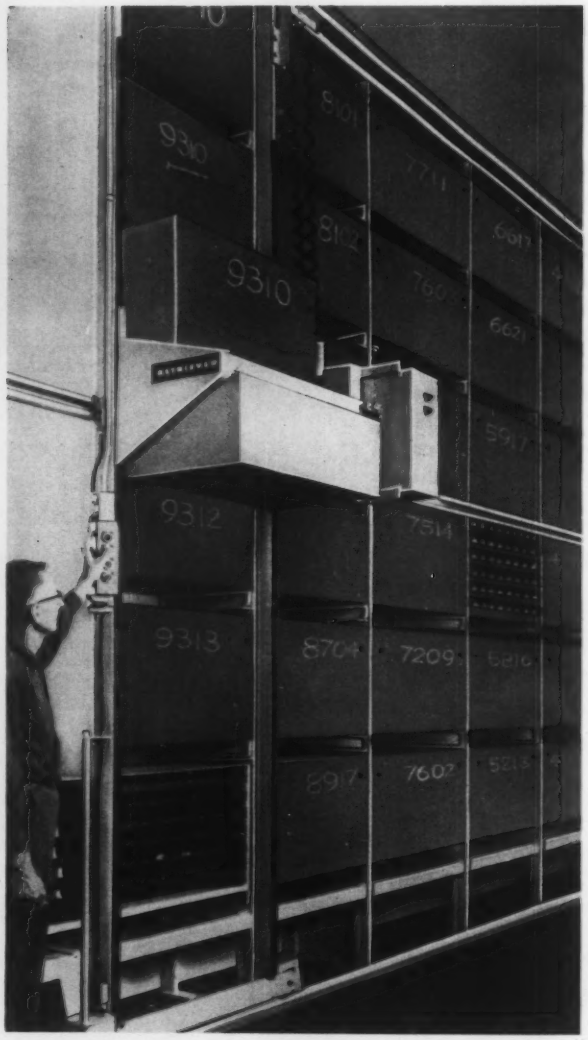
A spring-cushioned agitator located near the bottom of the seed hopper keeps the seeds loosened up with a minimum of injury to the seed.

A rubber-tired wheel is a new patented feature used to press grass seed a fraction of an inch into the soil. This special-design wheel replaces covering chains which were used for this purpose.



Elevator Position Controlled By Electric-Pulse Counter

ELEVATOR WITH A PUSH-PULL FLOOR automatically stores and picks up boxes of parts or materials in a mechanized "pigeon-hole" storage system. The elevator or carrier, called the Retriever, is powered by a two-speed electric motor. The motor raises or lowers the carrier on framework of two vertical masts which roll along tracks at the top and bottom of the storage wall.



VERTICAL POSITIONING of the carrier is controlled by a subtractive-type pulse counter which operates two motor limit switches. The operator sets the counter at a desired pigeon-hole level and presses the start button after the carrier and its supporting frame have been rolled into the desired column position. As the carrier passes each level, it subtracts out a number on the pulse counter.

As carrier and load approach the preselected storage opening, the pulse counter operates a limit switch which changes motor speed from high to low. When the load is directly in front of the desired opening, a second limit switch stops the carrier motor. A hydraulic cylinder pushes the carrier floor into the hole, sets the load down, and retracts.

Fully and semiautomatic storage systems of this type are designed and built by Triax Equipment, Cleveland, O. Elevating carriers can lift 4000 lb and can operate to heights of 21 ft.

Designing

INTERFERENCE FITS

By F. R. ARCHIBALD
Head, Applied Mechanics Group
Arthur D. Little Inc.
Cambridge, Mass.

What limits the strength of the assembly? Which will fail first? Shaft? Hub? Or will the shaft slip in the hub?

As a basis for design, here is a method for predicting those dimensions that will produce equivalent strengths of components and their assembly.

FROM the geometry of a shrink fit, Fig. 1, it is apparent that an increase in shaft diameter causes a decrease in hub stiffness, thereby decreasing the grip between hub and shaft. This suggests that there exists a shaft size which produces a fit of maximum strength. The strength of a fit may be defined in two ways — resistance to axial movement and resistance to torque. Ratio of shaft diameter to hub diameter which produces these maximum values is not the same for both conditions.

Force required to move the fit axially* is

$$F = \frac{2\pi\mu\sigma_e l b(a^2 - b^2)}{\sqrt{3a^4 + b^4}} \qquad (1)$$

*Lewis F. Moody—*Lectures on Machine Design*, Edwards Brothers Inc., Ann Arbor, Mich., 1946, p. 72.

where σ_e is the effective stress defined as

$$\sigma_e = \sqrt{\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}}$$

and the other terms are defined in the Nomenclature. Similarly, torque required to turn the shaft in the hub* is

$$T = \frac{2\pi\mu\sigma_e l b^2(a^2 - b^2)}{\sqrt{3a^4 + b^4}} \qquad (2)$$

If k represents the ratio of inside to outside hub radii, then $b = ka$ can be substituted in Equa-

Nomenclature

a = Nominal outside radius of hub, in.
b = Nominal inside radius of hub or outside radius of shaft, in.
F = Axial force, lb
$k = b/a$ = Ratio of nominal hub radii
l = Length of hub and shaft engagement, in.
T = Torque, lb-in.
μ = Coefficient of friction between mating surfaces
σ_e = Effective stress at ID of hub, psi
$\sigma_1, \sigma_2, \sigma_3$ = Principal hub stresses, psi
τ = Shear strength of shaft material, psi

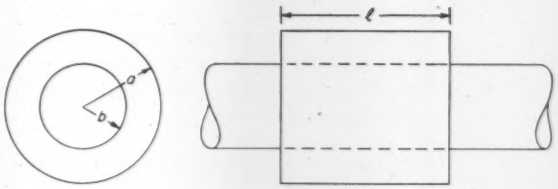


Fig. 1—Dimensional nomenclature for hub and shaft. Optimum ratio of nominal hub radii sets length of engagement necessary for maximum resistance to torque and axial thrust

tion 1 to give

$$F = \frac{2\pi\mu\sigma_e lak(1 - k^2)}{\sqrt{3 + k^4}} \quad (3)$$

In a like manner, Equation 2 becomes

$$T = \frac{2\pi\mu\sigma_e la^2k^2(1 - k^2)}{\sqrt{3 + k^4}} \quad (4)$$

To find the expressions for k required to produce maximum force or torque, the derivatives of Equations 3 and 4 are set equal to zero. This results in values of $k = 0.5643$ for maximum force and $k = 0.6938$ for maximum torque.

There is obviously a limit to the strength desired in the type of fit under consideration. For resistance to axial force, it is unnecessary to make the fit strength greater than the strength of the shaft in tension or compression. For resistance to torque, it is unnecessary to have the joint stronger than the torsional strength of the shaft.

Hence, for equal strength of joint and shaft in axial thrust (hub and shaft of same material)

$$\frac{2\pi\mu\sigma_e lak(1 - k^2)}{\sqrt{3 + k^4}} = \sigma_e\pi(ka)^2$$

which gives a required length of engagement:

$$l = \frac{ak\sqrt{3 + k^4}}{2\mu(1 - k^2)} \quad (5)$$

If k is chosen as the optimum, i.e., $k = b/a = 0.5643$, then

$$l = 0.7291\frac{a}{\mu} \quad (6)$$

Similarly, for equal strength of joint and shaft in torsion,

$$\frac{2\pi\mu\sigma_e la^2k^2(1 - k^2)}{\sqrt{3 + k^4}} = \frac{\pi\sigma_e(ka)^3}{2\sqrt{3}}$$

where $\sigma_e = \tau\sqrt{3}$. Hence

$$l = \frac{ak\sqrt{3 + k^4}}{4\mu(1 - k^2)\sqrt{3}} \quad (7)$$

Again choosing k at its optimum value, i.e., $k = 0.6938$ then the required engagement length for torsion is

$$l = 0.349\frac{a}{\mu} \quad (8)$$

Example: Assume that a preliminary check is to be made of a hub design for an interference fit on a 1-in. diameter shaft. What would the hub length and OD be for equivalent strength of the fit and the components in axial loading?

Assume a value for the coefficient of friction of $\mu = 0.2$. Then, Equation 6 gives $l = 0.7291a/0.2 = 3.646a$. Since $a = b/k$, then $a = 0.5/0.5643 = 0.886$ in. and the required diameter is 1.77 in. Therefore, the required engagement length is $l = 3.646\ (0.886) = 3.23$ in. If analysis of the fit under torsion is desired, a method similar to the preceding one is followed, using Equation 8 instead of Equation 6.

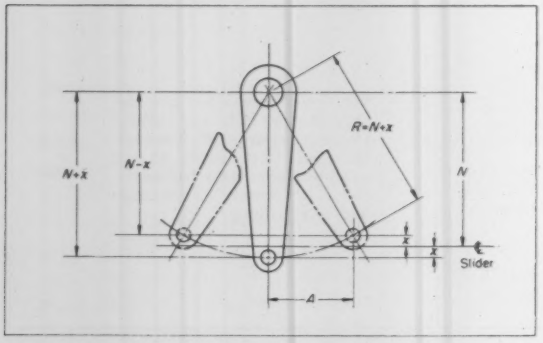
Circular Segments

Corrections are necessary to "Cones and Circular Segments," pp. 135-136, in the October 2 issue of MACHINE DESIGN. In Fig. 5, dimension q cot B should be q cot $2B$. In Fig. 3 (top), left dimension line of dimension $2R$ cos D should be as shown in Fig. 3 (bottom).

Tips and Techniques

Linkage Design

In designing linkages of the slider-crank type, the link radius, R, and link displacement, x, are often required. These values can be obtained from



$$R = \frac{A^2}{4N} + N$$

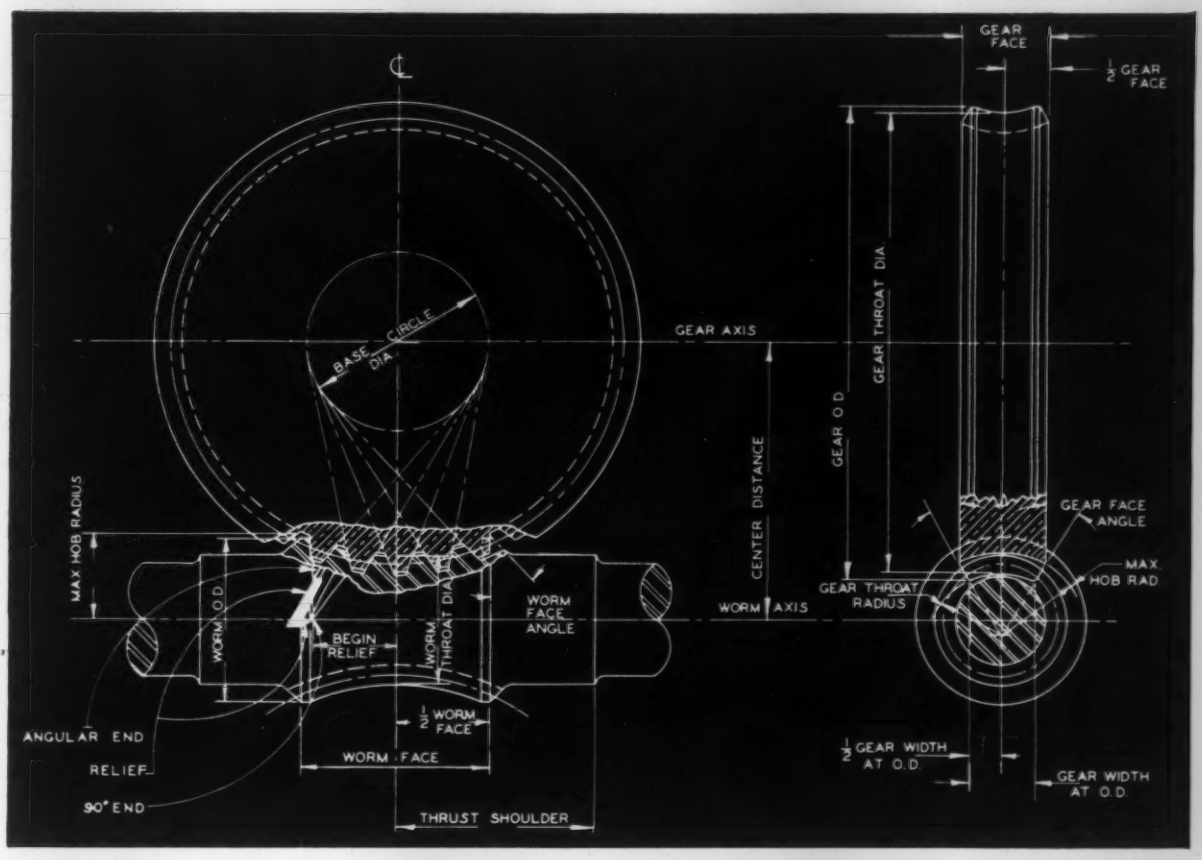
and

$$x = \frac{A^2}{4N}$$

when slider stroke, $2A$, and nominal distance, N, from center of link rotation to centerline of slider are known. This method eliminates the layout and graphical determinations usually employed.—LEONARD HELLER, *design engineer, Republic Aviation Corp., Mineola, N. Y.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

WORM GEAR DESIGN . . . *Bulletin #200*



Bulletin 200 has 20 pages crammed with 38 formulae, such as the Formula for Class I AGMA Horsepower Rating:

$$P = K_s K_m K_v \frac{n}{mg}$$

Step-by-step instructions, with typical examples, enable you to quickly determine the size worm gearset you need to meet any horsepower and service required.

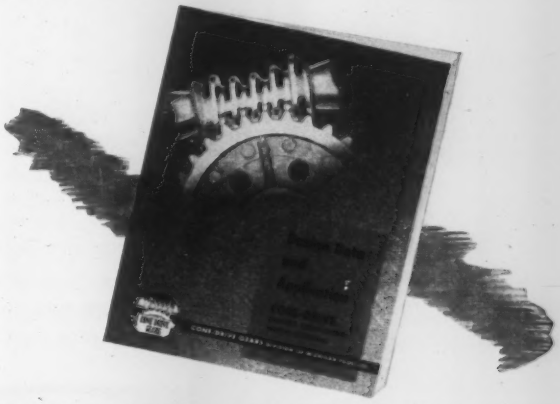
You can calculate the bearing loads and sizes needed for the worm and gear shafts.

You can check the worm root stress and gear tooth stress.

Efficiency is charted against helix angle with modifications for required speed so you can quickly determine efficiency.

One quick look at the drawing above will convince even the uninitiated that no other worm gearset has so many teeth in contact. No other worm gearset is so simple to design and rate. No other worm gearset will carry so much load in so little space with so little weight.

Now, Bulletin 200 provides complete design and application data on space-saving double-enveloping worm gearing. Ask for it without obligation.



CONE-DRIVE GEARS DIVISION MICHIGAN TOOL COMPANY

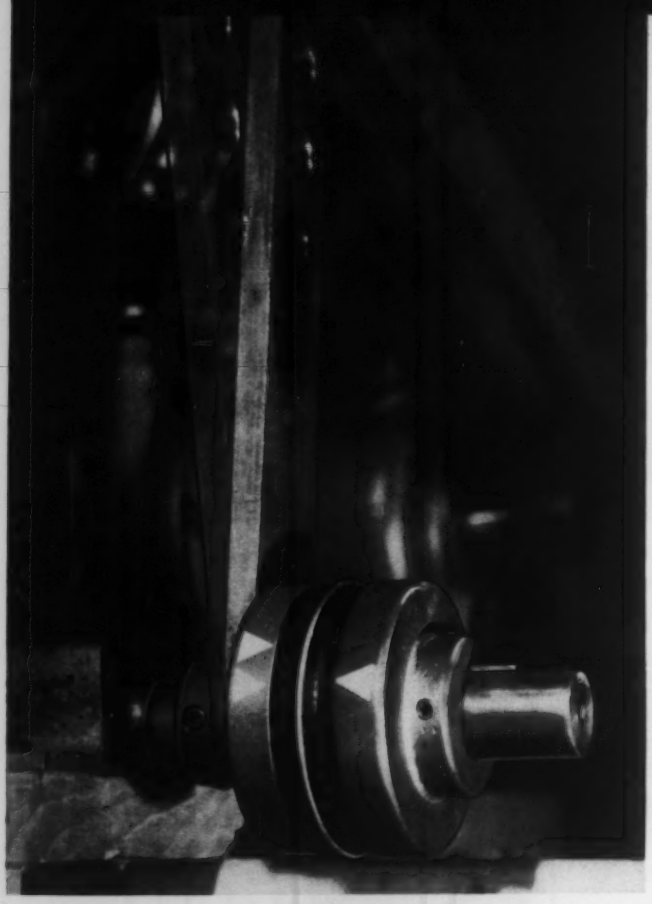
7171 E. McNichols Road • Detroit 12, Michigan • Telephone: TWinbrook 1-3111

DOUBLE-ENVELOPING WORM GEARSETS | DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS | DOUBLE REDUCTION WORM GEAR SPEED REDUCERS | DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

Circle 466 on Page 19

NEW WOOD'S SURE-FLEX COUPLINGS

SHOW NO FATIGUE AFTER 6 MILLION 15° DEFLECTIONS AT PEAK TORQUE!



New, Wood's Sure-Flex Couplings recently were submitted to severe tests to determine their ability to absorb destructive shock and vibration. They were deflected a full 15° at peak torque once per second, 24 hours per day, continuously for over 71 days. After more than 6¼ million cycles, they were examined and found to show only negligible signs of wear in the flexible sleeve. Most important, they remained completely satisfactory for operation under actual service conditions.

Wood's Sure-Flex Couplings absorb from 5 to 15 times more shock and vibration than other leading flexible couplings, resulting in increased motor and machine life. They withstand all combinations of misalignment and end-float without wear or high resisting forces. There are only 4 basic parts which lock together without clamps or screws, tightening securely under torque to provide smooth, dependable power transmission. There is no downtime . . . no need for lubrication or maintenance.

V-BELT DRIVES • VARIABLE SPEED DRIVES • TIMING BELT DRIVES • CARD DRIVES • FLEXIBLE AND RIGID COUPLINGS • FLYWHEELS • PULLEYS • MOTOR BASES • BALL BEARING PILLOW BLOCKS, FLANGE UNITS AND TAKE-UP BEARINGS • BABBITTED AND BRONZE BEARINGS • DUCTILE IRON PRODUCTS

WRITE FOR BULLETIN 10100A.

ATLANTA • CAMBRIDGE • CLEVELAND • DALLAS • NEWARK

Woods

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA

Circle 467 on Page 19

DESIGN ABSTRACTS

mechanical

The Heat Exchanger—An Economic Study

G. T. Atkins and N. O. Felps, Humble Oil & Refining Co.

An approach to the economic optimum in heat exchanger design. How initial costs of heat exchangers can be balanced against future maintenance by practicing economics of design and careful materials selection. A sample problem illustrates the method discussed.

ASME paper No. 58-HT-4, from ASME-AIChE Joint Heat Transfer Conference, Chicago, August, 1958; 3 pp.

Constant-Speed Drives For High-Mach Aircraft

F. L. Moncher and J. S. Cardillo, Vickers Inc.

A description of characteristics of components used in constant-speed drives and technical problems and their solutions in assembling these components into complete drive systems. Examples of actual hardware and test results are included. A recent design development in hydraulic pumps and motors which involves a new concept in the method of obtaining variable displacements from a piston unit of the bent-axis type is discussed.

SAE paper 94C, SAE National Aeronautic Meeting, Los Angeles, September, 1958; 10 pp.

Shock Spectra Characteristics And Their Uses

Y. C. Fung, California Institute of Technology, and M. V. Barton, The Ramo-Wooldridge Corp.

An indication of properties of the shock spectrum for single-pulse-type shocks which can be stated in general form. Previous work is extended to show that with proper normalization, certain properties of the shock spectra are insensitive to certain details of shock history. Practical use of such spectra to determine response of multi-degree-of-freedom systems is discussed.

ASME paper 58-APM-5, West Coast Conference of the Applied Mechanics Division, Los Angeles, September, 1958; 8 pp.

Large Symmetric Deflections Of Annular Plates

G. A. Wempner and R. Schmidt, University of Illinois

A series solution of the Von Karman equation for axially symmetric deflections of annular plates. A numerical procedure is described for evaluating coefficients in the series. Results are given for a plate subjected to axial edge-loads, and a method is presented for demonstrating convergence and appraising errors.

ASME paper 58-APM-12, West Coast Conference of Applied Mechanics Division, Los Angeles, September, 1958; 4 pp.

Transient and Residual Stresses In Heat-Treated Plates

H. G. Landau and J. H. Weiner, Columbia University

Equations for determining transient and residual thermal stresses in a heat-treated plate. Plate material is assumed to be elastic, and temperature is assumed uniform on any plane parallel to the faces of the plate. Stress distribution during unloading is determined without the simplifying assumption of simultaneous unloading. Stress-distribution sequence and residual stresses are calculated for several values of cooling rate and yield stress.

ASME paper 58-APM-14, West Coast Conference of Applied Mechanics Division, Los Angeles, September, 1958; 7 pp.

Natural Frequencies of Power Chains and Belts

F. R. Archibald and A. G. Emslie, Arthur G. Little Inc.

A derivation of the formula for the natural frequencies of a moving string as applied to calculations of natural frequencies of a power chain or belt. Results are also applicable to a vibrating gas column.

ASME paper 58-APM-7, "The Vibration of a String Having a Uniform Motion Along Its Length," West Coast Conference of the Applied Mechanics Division, Los Angeles, September, 1958; 2 pp.

Testing Aircraft Systems For Radiation Effects

M. M. Miller and A. M. Liebschutz, Lockheed Aircraft Corp.

Evaluation of aircraft systems performance characteristics in a radiation environment. Factors and requirements for conducting irradiations on dynamic systems are emphasized. Major requirements for test facility capabilities are discussed, and a test item is followed through a sequence of operations for a typical test program.

SAE paper 92C, SAE National Aeronautic Meeting, Los Angeles, September, 1958; 5 pp.

Escape Systems—A Design Methodology

A. I. Beck and G. Hildebrand, Republic Aviation Corp.

A discussion of design philosophy

of crew escape systems. Design criteria include ejection acceleration and separation, dynamic stability, deceleration and wind blast, altitude, and landing conditions. Each of these is covered as it affects final design configuration.

SAE paper 91C, SAE National Aeronautic Meeting, Los Angeles, September, 1958; 11 pp.

Designing For Maintainability

R. W. Manley, Hughes Aircraft Co.

A case history showing how the Falcon missile system was designed for maintainability. The maintenance concept, design objectives, test procedures, and design modifications are covered. Design objectives, formulated from the maintenance concept, are summarized.

SAE paper 93C, SAE National Aeronautic Meeting, Los Angeles, September, 1958; 7 pp.

Response of Complex Structures From Reed-Gage Data

S. Rubin, Hughes Aircraft Co.

Consideration of the general applicability of the reed gage. How recorded data permit calculation of peak response to a transient motion of a system having a single degree of freedom. Analysis is made of the error inherent in this process.

ASME paper 58-APM-15, West Coast Conference of Applied Mechanics Division, Los Angeles, September, 1958; 8 pp.

materials

Effects of New EP Lubricants On Elastomers for Oil Seals

John J. Murray, Chicago Rawhide Mfg. Co.

A review of test experiences with new extreme-pressure lubricants and their effects on synthetic rubbers of all types.

ASLE paper 58AM 1A-1, from ASLE 13th Annual Meeting, Cleveland, April, 1958; 13 pp.

Fatigue of Structural Materials At High Temperatures

B. J. Lazan

A discussion of the importance of fatigue as a cause of service failure at high temperatures. General nature of the fatigue process is reviewed with special emphasis on progressive fracture and statistical aspects. Engineering factors important in high-temperature fatigue are tabulated, and special attention is given to effects of beam stress, alternating stress, temperature, and stress concentration. Nature and general significance of creep phenomena are covered.

NATO Report 156, Sixth Meeting of the Structures and Materials Panel, Paris, France; 28 pp.

Boron Carbide

A brief discussion of the properties and new applications of boron carbide. Shaping of the metal by ultrasonic machining and advantages of the material in nuclear applications are mentioned. Available shapes of boron carbides and densities are included.

Carborundum's Advanced Materials Technology, *Vol. 1, No. 3, 1958; 2 pp.*

Design Suggestions For Brazed Honeycomb Sandwich

F. F. Rechlin, Solar Aircraft Co.

How conditions of the brazing process dictate and influence a designer's choice of configuration or material for the honeycomb sandwich. Methods for taking advantage of inherent characteristics of the process are covered. Each of six design suggestions is discussed in detail to show how design and process must correlate. Design of a hypothetical part is carried out in a step-by-step procedure to illustrate basic design points.

SAE paper 82C, SAE National Aeronautic Meeting, Los Angeles, September, 1958; 10 pp.

Dynamic Properties Of BTR Elastomers

G. W. Painter, Lord Mfg. Co.

Description of a new technique for measurement of viscoelastic properties of BTR (broad temperature range) elastomers over an extended range of frequency and dynamic strain. Dynamic properties of the elastomers under various environmental conditions are included.

SAE paper 83B, SAE National Aeronautic Meeting, Los Angeles, September, 1958; 13 pp.

High Temperature Properties of Four Wrought Steels

B. J. Connolly and G. Boyd

A compilation of data on short-time, high-temperature tensile and creep properties of four steels in common use. Steels tested include low-carbon (Cr-Mo) steel; medium-carbon, 1 per cent Cr-Mo steel; low-carbon, 3 per cent Cr-Mo steel; and a Cr-Ni austenitic steel. Effects of long-term heating under stress on microstructure and effect on room-temperature mechanical properties. Application of data to design and their relation to existing specifications are covered.

From a paper prepared for the Institution of Mechanical Engineers (Great Britain); 15 pp.

Glass for High-Temperature Electronic Components

James K. Davis, Corning Glass Works

A summary of new developments in glass for high-temperature electronic applications. Included are recent high-temperature advances in glass electronic components such as resistors, capacitors, and circuit boards, and the recent discovery of Pyroceram glass-ceramic materials.

AIEE Proceedings of the 1958 Electronic Components Conference, *pp. 186-194.*

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; papers 25 cents to members, 50 cents to nonmembers.

SAE—Society of Automotive Engineers Inc., 485 Lexington Ave., New York 17, N. Y.; papers 50 cents to members, 75 cents to nonmembers.

ASLE—American Society of Lubrication Engineers, 84 East Randolph St., Chicago 1, Ill.; papers 35 cents to members, 50 cents to nonmembers.

NATO—North Atlantic Treaty Organization, National Advisory Committee for Aeronautics, 1512 H St. N.W., Washington 25, D. C.

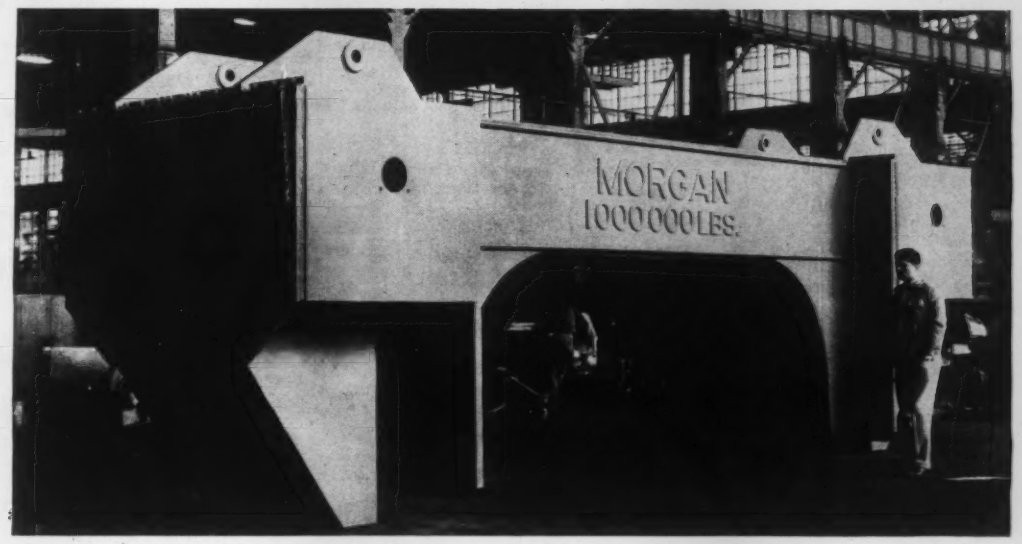
Advanced Materials Technology, The Carborundum Co., New Products Branch, Research & Development Div., Niagara Falls, N. Y.

The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, SW 1.

AIEE—American Institute of Electrical Engineers, 33 West 39th St., New York 18, N. Y.; papers 40 cents to members, 80 cents to nonmembers.

Weldynamics

ARC WELDING AT WORK CUTTING COSTS



All-Welded Lifting Beam for 500-ton hot metal ladle crane

More strength—less weight for world's largest ladle crane... *welded design does it for less money*

Maintaining highest possible strength with a minimum of weight is the prime objective in cranes like this. That's why welded construction is chosen.

Actually, 25% less steel is needed by welding these heavy cranes. This means material and fabricating costs are substantially lower. In addition, the crane is more maneuverable, availability higher, upkeep costs are lower.

Why not duplicate these benefits in your products now? Write us to show you how.

DESIGNERS! ENGINEERS! New 11th Edition Procedure Handbook of Arc Welding Design and Practice has 1300 pages of complete and up-to-date engineering data to help you develop efficient, low cost product designs. $3.00 in U.S.A. postpaid, $3.50 elsewhere.

The prime objective was to accomplish the highest possible pay load with assurance of uniform stress conditions and uniform material throughout with a minimum of weight at the lowest possible cost. These objectives were achieved by the extensive use of welded design throughout.

C. F. SIMMERS, Vice President, Engineering
The Morgan Engineering Co.

The World's Largest Manufacturer of Arc Welding Equipment

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Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card — page 19

Terminal Blocks

How extensive line of terminal blocks simplifies wiring, minimizes assembly costs, and assures lasting connections is related in illustrated Catalog 129 CEC 30. Specifications of all available types are given. Also covered are power outlets and electronic switches. 20 pages. Kulka Electric Mfg. Co., Mount Vernon, N. Y. D

Circle 551 on Page 19

Vinyl-Coated Metals

Laminol, a vinyl to aluminum or steel laminate which can be fabricated into many products, is described in folder. Sheets to 32 x 114 in. and coils up to 32 in. wide are offered. 6 pages. American Nickeloid Co., Peru, Ill. I

Circle 552 on Page 19

Flexible Coupling

Catalog supplement No. 1 describes the Gear Grip 5-G miniature flexible coupling available in 1/8, 3/16, and 1/4-in. shaft sizes. 1 page. Guardian Products Corp., Coupling Div., Michigan City, Ind. J

Circle 553 on Page 19

Thermocouple Assemblies

Catalog 1885 on line of thermocouple assemblies and pressure sealing glands introduces new additions such as Conax Type C bare wire thermocouple glands, roll temperature thermocouples and other Conax products. Complete technical data, prices, and ordering information are provided. Explosive actuated products are covered as well. 36 pages. Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y. N

Circle 554 on Page 19

Clutches & Brakes

Dyna-torQ magnetic friction clutches and brakes, operating on 110-v ac will respond to electrical signals from remote control system, suiting them for automatic programming and cycling. Details are provided in illustrated Bulletin RSF-1. 8 pages. Eaton Mfg. Co., Dynamatic Div., Kenosha, Wis. K

Circle 555 on Page 19

Indexing Device

A basic 24-in. model of the Super Spacer indexing unit is illustrated in folder with attachments and a parts breakdown. Unit is accurate to within 1 min of arc. 4 pages. Hartford Special Machinery Co., Homestead Avenue, Hartford, Conn. B

Circle 556 on Page 19

Rubber Parts & Products

Rubber products made by this company and illustrated in Form 236 C include Gorlube rubber treatment, Tetraseals O-ring seals, O-rings, molded and cut rubber products, and bonded-to-metal parts. Company facilities are illustrated and described. 4 pages. Goshen Rubber Co., 3408 S. Tenth St., Goshen, Ind. J

Circle 557 on Page 19

High Speed Vises

Tool application problems and solutions relative to a line of screwless, fast production vises and automatic self-centering air vises are dealt with in Catalog 158. Operation and maintenance instructions are included with drawings and dimension tables. 28 pages. Heinrich Tools, Inc., Racine, Wis. K

Circle 558 on Page 19

Alloy Tubing & Pipe

Special purpose alloys for tubing and pipe used in aircraft, missile, rocket, nuclear energy, and chemical fields are covered as to sizes, gages, finishes, chemical composition, and mechanical and physical properties in Bulletin T.D. 125. Data also include fabrication characteristics and corrosion resistance information. 8 pages. Carpenter Steel Co., Alloy Tube Div., Union, N. J. D

Circle 559 on Page 19

Pressure Switches

Catalog CEI-602 covers complete line of miniature, precision pressure switches, including altitude, differential, gage, and the new absolute types. Operating pressures range from a few inches of water up to 10,000 psi. Units sense small pressure changes in systems handling varieties of gas. 28 pages. Century Electronics & Instruments, Inc., 1333 N. Utica, Tulsa 10, Okla. P

Circle 560 on Page 19

Test Equipment

Volt-ohmmeters, vacuum tube volt-ohmmeters, microtesters, refrigeration, and air conditioning test equipment comprise line of test equipment described in Brochure 2060. It is compiled for electronic, electrical, air conditioning, and heating equipment industries. 8 pages. Simpson Electric Co., 5200 W. Kinzie, Chicago 44, Ill. I

Circle 561 on Page 19

Polyethylene Technology

The technology of polyethylene plastic, from basic chemistry of the resins to fabrication of end products, is covered comprehensively in processing guide. Handbook blends old and new data and details many specific problems which confront the processor. Sections deal with a general description of polyethylene; uniformity, compounding and blending; and packaging and shipping of Petrothene resins. 100 pages. U. S. Industrial Chemicals Co., 99 Park Ave., New York 16, N. Y. D

Circle 562 on Page 19

Tube & Hose Fittings

Bulletin 480 tabulates tube and thread sizes on tube and pipe fittings, hose, hose couplings and fittings, swivels, and check valves. Tools and accessories briefly described include tubing installation tools, flaring tools, and cutters. 12 pages. Trabon Engineering Corp., 28815 Aurora Rd., Solon, Ohio. F

Circle 563 on Page 19

Cap Nuts

Standard specifications for diecast zinc alloy cap nuts cover regular closed end cap nuts, open end cap nuts, and high closed end cap nuts. Specs cover blank sizes, thread sizes, principal dimensions, and approximate shipping weights. Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y. D

Circle 564 on Page 19

Magnesium Castings

"Cast-in Inserts and Tubeless Passages in Magnesium Castings" is title of bulletin describing the McCannacore Process for integral casting of internal tubeless passages in light alloy castings. 8 pages. Hills-McCanna Co., 2406 W. Nelson St., Chicago 18, Ill. I

Circle 565 on Page 19

Valve Couplings

Bulletin 551 on Quick-As-Wink valve couplings, hose couplings, and clamps features a tabular chart of dimensions. Valve couplings are offered in 1/4, 3/8, 1/2, and 3/4-in. sizes; hose couplings in 1/4 to 4-in. sizes. 4 pages. Hunt Valve Co., Salem, Ohio. G

Circle 566 on Page 19

PVC Properties

Folder 273-56 provides data on resistance or nonresistance of polyvinyl chloride to a complete range of chemicals. Data are based on temperatures of 72 and 140° F. 6 pages. Electric Storage Battery Co., Stokes Molded Products Div., Taylor at Webster Street, Trenton 4, N. J. E

Circle 567 on Page 19

Resin-Treated Clays

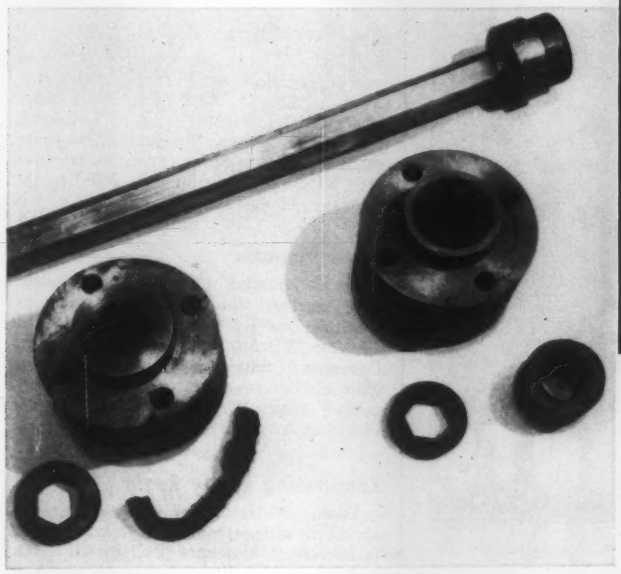
Resin-treated clays, used in reinforced plastics as fillers, are subject of Technical Bulletin TSBT-84. Included are graphs and tables on properties, performance, and advantages of the products. Physical test results are given. 10 pages. Georgia Kaolin Co., 21 Parker Rd., Elizabeth 3, N. J. D

Circle 568 on Page 19

"Cast Urethane* parts that outwear steel cut maintenance costs 65% on this pneumatic hammer..."

says H. B. Minturn
Mechanical Superintendent
The Ormet Corporation†

Urethane elastomer components replaced machined steel parts in these pneumatic hammers; show no sign of wear after four months of punishing use, says Ormet's H. B. Minturn (right).



After comparable periods of service, superior wear resistance of cast urethane bushing (right) over machined steel shaft guide with lead graphite packing (left) is obvious. Resiliency of urethane inserts also reduces angular stress on shaft in operation.

"The replacement of steel inserts with cast urethane parts in our pneumatic sand ramming hammers has resulted in a two-thirds reduction in maintenance, with attendant savings in cost of spare parts," says Mr. H. B. Minturn of Ormet Reduction Plant, Hannibal, Ohio.

The steel nose pieces of the rammers, used to tamp a 12-ton mixture of calcine, anthracite coal and foundry coke which lines the cathodes of large electrolytic cells for producing pure aluminum, had a service life of only one to two months. Lead packings lasted less than half that long. "This meant we were losing 2½ hours of potential production time to maintenance every time one of these units had to be torn down to replace the worn parts," Mr. Minturn adds.

"Cast urethane parts have eliminated these problems. The urethane linings in the nose pieces and packing rings seem to be indestructible and show no signs of wear after four months of constant use. The use of urethane parts has given us an added advantage by enabling us to redesign the gasketing to include grease rings which further reduce wear on the shaft and other working parts.

"To sum up, we have really found a tough, friction-resistant material in this elastomer—one which is easily machinable, resilient and low in cost."

†The Ormet Corporation, jointly owned by Olin-Mathieson and Revere Copper and Brass, Inc., is typical of the basic industries that are finding urethane elastomer a ready-made answer to some of their toughest maintenance problems.

MOBAY
CHEMICAL COMPANY
Dept. H-2 • Pittsburgh 34, Pa.

MOBAY
First in Urethane Chemistry

*The exceptional properties referred to in this application story are obtainable only in urethane elastomers made with Mobay's chemicals. Write to Mobay Chemical Company for technical details and sources of fabricating assistance.

Circle 469 on Page 19

Make your next connection with

asg UNIVERSAL JOINTS

They are made to provide smooth, more efficient transmission of power and are available from stock in 13 sizes with bored or solid hubs ranging from .375" to 4.000". Special bores, bores with keyways or setscrews are available upon special order.

The close limits to which all parts are held assure maximum load carrying capacity with durability and long life. All parts are made of preheat-treated alloy steel and are precision ground to insure high quality and interchangeability of components. Joints with hub diameters of .750" and larger have a self-closing snap ball oiler while the small pin is held in place with a self-locking snap ring. The snap ring simplifies assembly and disassembly.

Send today for Bulletin No. 527 describing the full line of ASG Universal Joints available from your nearest distributor.

AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY **HARVEY, ILLINOIS, U.S.A.**

Dust Collector

The Joy Microdyne is a wet inertial type dust collector installed as part of the duct and capable of collecting 95 per cent of all dust 5 microns in size. Bulletin J-616 provides performance curves, specs, and inner construction drawings. 12 pages. Joy Mfg Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa. F

Circle 569 on Page 19

Extruded Acrylic Sheets

Handling, machining, forming, cementing, and annealing of Cadco extruded acrylic plastic sheets are detailed in Bulletin EX-101. A table of properties, four pages of light transmittance charts, including comparison with cast sheet, and reflectance data are included. 12 pages. Cadillac Plastic & Chemical Co., 15111 Second Ave., Detroit 3, Mich. H

Circle 570 on Page 19

Rectifier Power Units

Data and specifications for selenium and silicon rectifier power units are available in Catalog 47190-2H. Three-phase and special low voltage units, both with ¾ to 500 kw capacities, and single-phase units with ¼ to 3 kw capacities are covered. 10 pages. Syntron Co., 260 Lexington Ave., Homer City, Pa. F

Circle 571 on Page 19

Wire Markers

Four thousand different self-adhesive wire markers which conform to various specifications are described in illustrated Catalog 130. All temperature vinyl-cloth, flameproof aluminum foil, oil resistant, glass cloth, and miniature types are covered. 8 pages. W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis. K

Circle 572 on Page 19

Laminating Epoxy Resin

Epolite 90 laminating epoxy resin, used for both surface coating and laminating, is subject of illustrated Bulletin RPD900. It features high flexural strength and low cold creep. Physical properties and typical uses are given. 4 pages. Rezolin, Inc., 1651 18th St., Santa Monica, Calif. L

Circle 573 on Page 19

Screw Thread Service

Service outlined in Form 2369 is intended to help industry solve fastener fit problems. Handbook reviews both function and facilities of each of three Screw Thread Metrology Laboratories recently opened. Featured is a 7-page appendix of reference material with pertinent data on screw thread dimensions and tolerances. 20 pages. Standard Pressed Steel Co., Jenkintown, Pa. C

Circle 574 on Page 19

Air Clutch

Stationary air housing, interchangeability with mechanical clutch applications, and one basic drive for six different applications are features of the Stationaire air clutch. Its construction details are presented in illustrated Bulletin 858. Conway Clutch Co., Cincinnati 25, Ohio. G

Circle 575 on Page 19

Circle 470 on Page 19

PRODUCT-DESIGN MEMOS FROM DUREZ

High-impact phenolic | **Automatic molding**
Phenolic for appliances

Flying saucer?

This plastic housing helps airmen find out what's cooking on the roof of the world.

It's part of a radiosonde, a device that has sparked many flying-saucer reports.

Dropped from a high-flying weather reconnaissance plane over an ocean or arctic ice, the radiosonde flips its plastic lid, releasing a parachute.

The ballooning chute yanks an antenna line out of the case. Then, as the device drifts groundward, it broadcasts a code report on air temperature, pressure, and humidity every six seconds.

Picked up by radio men, these signals enable the Air Force to piece together accurate forecasts of flying weather over remote frontiers.

The snap-off housing is molded of *Durez 16771 Natural*, selected for its impact strength and its ability to stand extremes of temperature and humidity.

In sharp contrast to the mass production of phenolic parts, this use of Durez suggests its ability to meet *your* out-of-the-ordinary requirements.

If you'd like technical data on 16771 Natural, check the coupon. For information on other special-purpose phenolics, write us, outlining the problem.

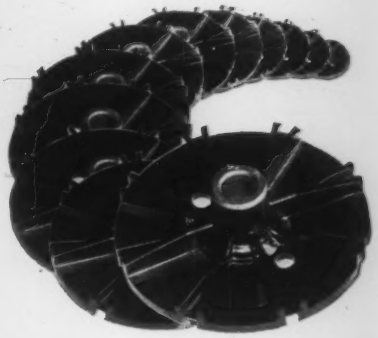
Big job, big saving

What's hot in phenolics? *Automation.*

Automatic molding of a 4¾-inch diameter water-pump impeller for new Ford cars, trucks, and tractors has made possible a switch from cast iron to phenolic —with substantial reductions in weight, production time, and cost.

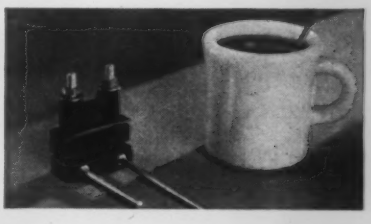
The impellers are molded 12 at a shot on the largest capacity compression molding press ever to operate on fully automatic cycle.

The material selected for the impeller is a Durez phenolic impervious to antifreeze and antirust solutions, combining moisture resistance with dimensional stability in high degree.



Thinking big? You'll find there are many ways in which mass-production molding and Durez phenolics can team up profitably for you. The versatility and exceptional batch-to-batch uniformity of these compounds assure best possible results on highly automated production lines.

Ask your molder or your Durez sales representative to suggest how you can put these advantages to work in your products.



Durez and the coffee-break

Appliance makers can tell you that wherever coffee perks, bubbles, or pours into a cup, there's likely to be a Durez phenolic close by.

Electrical components, handles, knobs —these are just a few essentials of a coffee-break, in which Durez molding compounds play an unassuming part.

A prime requisite for this sort of assignment is the ability of phenolic to resist coffee stains and chemical deterioration. The appliance designer also looks for:

- excellent surface finish
- good dimensional stability
- coolness to the touch
- crack resistance when molded around large inserts

If *you're* looking for properties like these, you can find them all in *Durez 791 Black*. They're exemplified in the component shown here, an electrode assembly for a king-sized coffee maker and dispenser.

For more facts on versatile 791 Black, check the coupon.

For more information on the Durez materials mentioned above, check here:

- ☐ High-impact Durez 16771 Natural—data sheet
- ☐ Phenolic molding compounds—descriptive bulletin
- ☐ General-purpose Durez 791 Black—data sheet

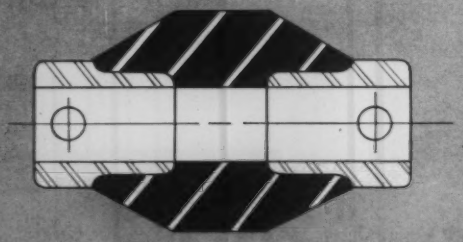
Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ® HOOKER CHEMICALS PLASTICS

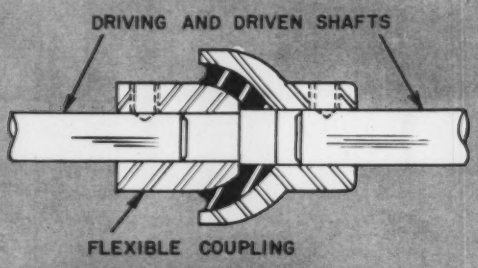
PLASTICS DIVISION
HOOKER CHEMICAL CORPORATION
510 Walck Road, North Tonawanda, N. Y.

Circle 471 on Page 19

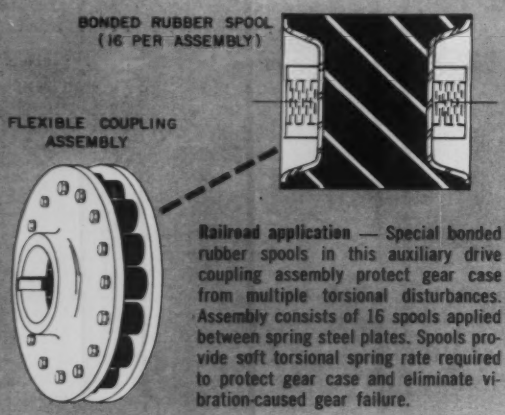
custom-designed LORD flexible couplings provide improved equipment performance



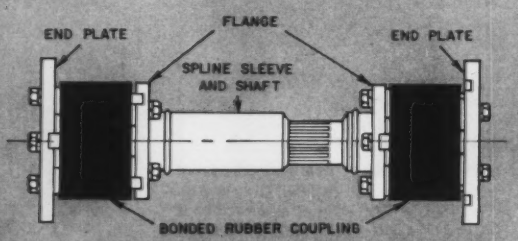
Business machine application — This coupling is uniquely applied in series of four pieces in gear train of business machine. Bonded rubber construction virtually eliminates noise transmission and accommodates shaft misalignment, assuring fast, accurate operation. Special elastomer contour imparts exact degree of torsional stiffness required.



Home appliance application — Special close-tolerance coupling transmits high motor torque in rugged washer-dryer application. Custom-compounded elastomer withstands high operating temperatures. Coupling accommodates 2° shaft misalignment, reduces noise and bearing wear.



Railroad application — Special bonded rubber spools in this auxiliary drive coupling assembly protect gear case from multiple torsional disturbances. Assembly consists of 16 spools applied between spring steel plates. Spools provide soft torsional spring rate required to protect gear case and eliminate vibration-caused gear failure.



Marine application — Custom-designed, non-magnetic coupling assembly, used on minesweeper main propulsion shaft, attenuates noise and accommodates shaft misalignment. Rated at 15,400 in.-lb. torque, it accommodates continuous misalignment of ¾" and momentary misalignment of 1¼" in all directions. Coupling is typical of high horsepower applications featuring optional fail-safe protection.

You will get optimum product performance with special Lord Flexible Couplings regardless of the specific requirements of your application.

Here are the performance benefits you can obtain. Efficient isolation of torsional vibration and shock. Accommodation of all misalignment—angular, parallel and axial. Smooth, quiet, constant speed transmission of power with no backlash. No lubrication or maintenance. Extreme overload protection. Long service life despite tough operating conditions. Torque capacities from inch-ounces to foot-tons.

Bring your flexible coupling problems to Lord where you will find complete research, test and production facilities. Here, 20 years of engineering experience in flexible coupling design can produce an accurate solution for your application.

Contact your nearest Lord Field Engineer or the Home Office, Erie, Pennsylvania.

FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - CEdar 7-9247
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CHICAGO, ILL. - MIchigan 2-6010
CLEVELAND, OHIO - SHadyside 9-3175
DALLAS, TEXAS - RIverside 1-3392
DAYTON, OHIO - BAldwin 4-0351
DETROIT, MICH. - DIamond 1-4340
KANSAS CITY, MO. - WEstport 1-0138
LOS ANGELES, CAL. - HOllywood 4-7593
NEW YORK, N. Y. - CIrcle 7-3326
PHILADELPHIA, PA. - PEnnypacker 5-3559

"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

LORD
BONDED RUBBER

Circle 472 on Page 19

Welding Supplies

Over 100 photos illustrate Catalog 9-13 on welding supplies and accessories. It covers Airco fluxes and ferrous and nonferrous rods for gas welding, protective clothing, goggles, electrode holders, sparklighters, cable, hose, weld cleaning tools, and cylinder trucks. 52 pages. Air Reduction Sales Co., 150 E. 42nd St., New York 17, N. Y. D

Circle 576 on Page 19

Special Purpose Fasteners

Principle of operation, purpose and applications of special cap and set screws; plug and lock nuts; W-bolts, bent bolts, weather-tight sheathing bolts, key and place bolts; line clamps; bulldog clips; pipe plugs; and Sems are listed in engineer's guide. 8 pages. Lamson & Sessions Co., 1971 W. 85th St., Cleveland 2, Ohio. G

Circle 577 on Page 19

Stampings in Any Quantity

Metal stampings in any quantity can be produced from blanks up to 22 x 22 in. and up to ⅜ in. thick by this company. Typical stampings are described and illustrated in Bulletin F185. They can be made from many materials to close tolerances. 8 pages. Dayton Rogers Mfg. Co., 2824 13th Ave. S., Minneapolis 7, Minn. J

Circle 578 on Page 19

Air Valves & Actuators

Basic types of air valves and actuators, plus temperature control and positioning systems, and specialized electrical test equipment are described in brief in Folder F-5910-1. 4 pages. Barber-Colman Co., 1400 Rock St., Rockford, Ill. K

Circle 579 on Page 19

Polyurethane Foam

Permathane foam cushioning and padding material, made from durable polyurethane foam, is built into mobile equipment seats and can be cut or molded to any shape, size, or design, according to illustrated Folder 158. Typical forms are shown. 4 pages. Bostrom Corp., 133 W. Oregon St., Milwaukee 4, Wis. K

Circle 580 on Page 19

Connector Plugs

The XLR line of audio-electronic connectors for use on microphones, tape recorders, amplifiers, test instrumentation, computors, and other electronic instruments is detailed in a Catalog XLR-3. Ordering data and dimensions are given. 4 pages. Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. L

Circle 581 on Page 19

Open Type Motor

Available in all integral horsepower frames, Super-Seal open type motors are unaffected by moisture, dust, dirt, oils, acids, and alkalies. Design features, application data and rating tables are included in illustrated Bulletin 05-51B9040. 6 pages. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. K

Circle 582 on Page 19

ONE PART REPLACES FIVE!

BY POWDER METALLURGY

Tremendous savings and performance advantages resulted when Dixon Sintaloy Engineers, in collaboration with the Briggs & Stratton Corporation, redesigned this five-piece cam and ratchet as a single powder metallurgy part. Excellent bearing qualities plus self-lubrication of the Sintaloy iron-copper part eliminated the need for the bronze bearing insert and thrust washer. The cam is now integrally formed and heat treating provides the required surface hardness. Since the ratchet no longer has to be machined from stock shapes, the most efficient contour can be employed and formed right in the part. Delivered to Briggs & Stratton, ready-to-use, the Sintaloy part with inherently fine surface finish and close tolerances, minimizes inspection, eliminates further finishing, simplifies inventory, and frees production facilities for other work.

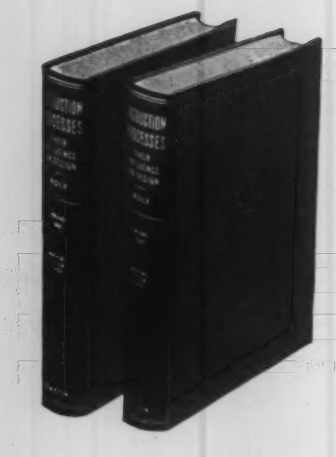
These are but some of the outstanding advantages of Sintaloy Powder Metallurgy in one particular case. It costs nothing to determine how it can also provide similar advantages for you. Write today for illustrated brochure with full design data.

DIXON SINTALOY INC.

a subsidiary of The Joseph Dixon Crucible Company
535 Hope Street, Stamford, Connecticut

Circle 473 on Page 19

how to design for LOW COST production



- 924 pages of fully illustrated text
- Covers 56 different processes
- Includes 9 major production areas

"PRODUCTION PROCESSES"

THEIR INFLUENCE ON DESIGN, by Roger W. Bolz

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Mass Production and Design
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Metal Forming
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Casting Methods
Molding Methods
Fabricating Methods
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The most practical books ever written on production processes and their influence on design . . . by one of the country's outstanding authorities on production processes, Roger W. Bolz.

Here is a "shop approach" to design that can be your guide to lower costs while products are still in the drawing-board stage.

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☐ Remittance enclosed in which case the books will be sent postpaid.
☐ Bill me ☐ Bill my company ☐ C. O. D.

NAME _____
TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

Drum Type Controllers

Operation, use, construction, installation, specifications, and features of drum type controllers which open or close either air pilot valves or electric switches are covered in illustrated bulletin. Specifications of various types are included. 8 pages. Seely Instrument Co., Box 387, Niagara Falls, N. Y. N

Circle 583 on Page 19

Diaphragm Compressors

Capable of handling all types of liquids and gases, the diaphragm compressors detailed in Bulletin 4071 have outlet pressures ranging from 50 to 15,000 psi and capacities to 60 scfm. Various applications are outlined and construction is shown. 6 pages. American Instrument Co., 8030 Georgia Ave., Silver Spring, Md. C

Circle 584 on Page 19

Precision Tubing

Sizes from 0.010 to 1.125 in. OD are available in various shapes, preformed, Bourdon, and Coaxitube forms of precision tubing. Available alloys, their properties and applications, working properties, tolerances, and other data are included in illustrated brochure. 12 pages. Precision Tube Co., North Wales, Pa. E

Circle 585 on Page 19

Sealed Relays

Information on hermetically sealed relays for military and general purpose industrial uses are found in Bulletin GEA-6628. Photographs, circuit diagrams, coil data, and specifications for micro-miniature, subminiature, miniature, and high speed relays are included. 24 pages. General Electric Co., Schenectady 5, N. Y. C

Circle 586 on Page 19

Enclosed Switches

Line of E6 and V6 small enclosed switches can be wired "in a jiffy," according to illustrated Bulletin 21. Split design enclosure exposes the basic terminals for easy wiring. Other features and six available actuator designs are covered. 4 pages. Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill. K

Circle 587 on Page 19

Nut Staking Units

Strippit pierce nut units for staking Fabristeel nuts into sheet metal for assembly panel production are described in illustrated Catalog L1462. Operation and specifications of press-actuated Type CD and BL units are covered. 4 pages. Wales-Strippit, Inc., 216 S. Buell Rd., Akron, N. Y. N

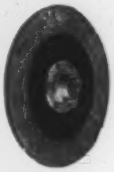
Circle 588 on Page 19

Index Tables

High speed indexing equipment, standard index tables, standard transfer machines, stored energy clutch-brake transmitters, and assembly machines are described in illustrated Catalog 302. Selection data and specifications are included. 16 pages. Ferguson Machine Corp. of Indiana, 7818 Maplewood Industrial Court, St. Louis 17, Mo. J

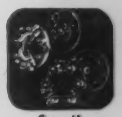
Circle 589 on Page 19

ROCKFORD



Morlife® whole-ring, powdered-metal-base, clutch plate facing provides smooth, powerful, non-scoring friction contact for heavy-duty operation.

Morlife® button-type, ceramic-and-metal clutch plate facing provides powerful torque grip for use in off-highway, heavy-duty machines.



Small Spring Loaded

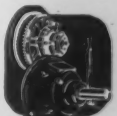
Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center



Power Take-Offs

Speed Reducers

How You Can Get the RIGHT FACING For Your Clutches

ROCKFORD CLUTCHES are made with a wide variety of friction plates—to meet your specific needs, exactly. Powdered-metal, ceramic-and-metal, metalic and organic facings provide the *right* torque, wear and heat-disbursal characteristics for every type clutch. Because ROCKFORD engineers have this wide range of facings available, they can help you select just the right friction material to suit your need.

Solid-ring or segmented, metal clutch plate facings provide for use in machines where metal-to-metal friction contact is indicated.

An extensive variety of organic friction facings for all types of clutch plates is available for use with ROCKFORD clutches.

SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

ROCKFORD Clutch Division BORG-WARNER

311 Catherine St., Rockford, Ill., U.S.A.

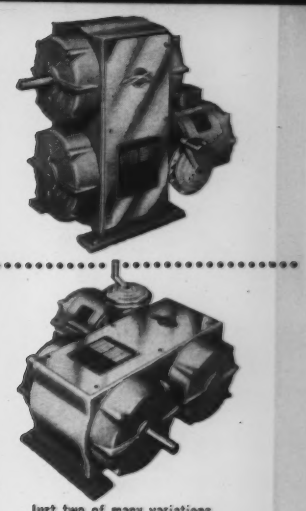
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ROCKFORD B-W BORG-WARNER

CLUTCHES

Circle 476 on Page 19

Conduit box can be located top, bottom, or either side.
Control hand wheel can be positioned on top or either side.
All end-bracket assemblies are interchangeable for repositioning of drive components.
Motor can be mounted top or bottom.
ALLISPEDE
MECHANICAL ADJUSTABLE SPEED DRIVE
THE ELLIS ALLIS CO.
GET ALL THESE VARIATIONS
FROM ONE BASIC DESIGN
—with wrench and screwdriver!



Just two of many variations that can be made from a standard ALLISPEDE DRIVE.

Another NEW product from Louis Allis

The ALLISPEDE* DRIVE gives you complete design versatility!

"Building-block" principle, using one basic unit, permits this drive to fit into any design requirement regardless of space or shape limitations!

The *all-new* ALLISPEDE DRIVE is a simple answer to the problem of providing low-cost adjustable speed in a variety of designs. The basic unit goes together like blocks — you pick the assembly you want — locating feet, end brackets, control hand wheel, conduit box, and output shaft to suit the requirements of the driven machine.

Output shaft can be high or low, right or left.

The same unit can be used for horizontal or upright floor, wall, or ceiling mounting — there are no "fixed" components to limit installation. And all of these adjustments are easily made in minutes with just a wrench and screwdriver, right on your assembly floor! As a result, a lower inventory of drives still covers your production requirements.

Superior design improves drive efficiency and extends service life. The four bearings equally distribute belt load, increasing bearing and belt life. Movable discs slide smoothly on internally-lubricated splined shafts — won't stick in place or wear.

Rugged cast-iron housing with plated steel covers shields drive against dirt and corrosion . . . integral rotor fan cools the motor and force-ventilates the drive housing to extend bearing life. Oversize cartridge bearings are pressed on shaft and lubricated at the factory. Corrosion-resistant stainless-steel nameplates diagram proper motor connection, specify bearing sizes, and carry complete instructions for operation and lubrication.

Detachable feet can be bolted to bottom, side, or top for floor, wall, or ceiling mounting.

The ALLISPEDE DRIVE can be supplied with in-line or right-angle integral gears, brake, and tachometer. Sizes from 1 to 20 HP, with speed variations up to 8:1. Electrical and mechanical modifications for any application.

Contact your Louis Allis District Office or Distributor for complete information and engineering assistance. Or write for Bulletin 3300, The Louis Allis Co., 459 E. Stewart St., Milwaukee 1, Wis.

**ALLISPEDE is a trademark of The Louis Allis Co.*

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

Circle 477 on Page 19

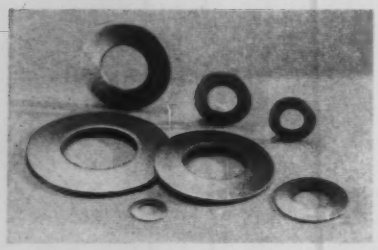
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Belleville Spring Washers

have load range from 30 to 1200 lb

Belleville spring washers give economy of space combined with highest load and greatest deflection possible at a given stress level. Washers are available in two thicknesses of stock in each of seven diameters from 0.375 to 1.500 in. OD and 0.190 to 0.755 in. ID. Load range for single units is from 30 to 1200 lb. Residual stresses are introduced



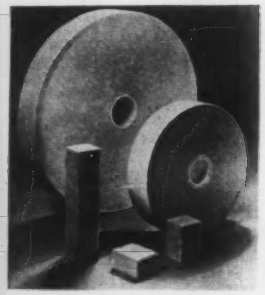
during manufacture so washers can be compressed to flat position and released without loss of free cone height in spite of high apparent stress. **Associated Spring Corp.**, Bristol, Conn. B

Circle 590 on Page 19

Honeycomb Ceramics

withstand temperatures to 1000 C

Cercor thin-walled ceramics formed into lightweight honeycomb structures withstand temperatures up to 1000 C with virtually no thermal expansion, and operate continuously at 700 C. At these temperatures they are resistant to oxidation and corrosion, and withstand extreme thermal shock. Applications include use in gaseous heat exchangers, as catalyst supports, as air preheaters and aftercoolers, burner plates or covers, column packing material, or as architectural material where lightness, thermal shock resistance,



and high-temperature strength are required. Available pieces have compressive strength, parallel to channels, of 2000 psi. Surface area of the 20-hole-per-in. corrugated structures is 1500 sq ft per cu ft of material. Material has density of about 30 lb per cu ft and specific heat (room temperature) of 0.20. **Corning Glass Works**, Corning, N. Y. D

Circle 591 on Page 19

Miniature Servo Valve

for operating pressures to 3000 psi

Model 410 miniature hydraulic servo valve has maximum flow range from ½ to 5 gpm with 1000 psi drop, and is for operating pressures from 300 to 3000 psi. First and second stages receive and pass on particles as large as 200 mu without malfunctioning. First stage hydraulic preamplifier has only one source of oil and cannot become unbalanced due to oil contamination. Valve incorporates a frictionless, high-gain, push-pull force-feedback servo that controls second

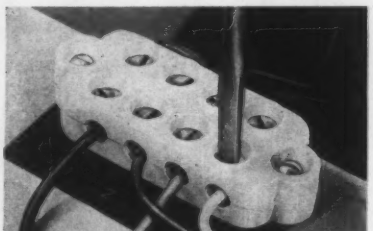
stage. Hermetically sealed torque motor is isolated from hydraulic fluid. Unit has low hysteresis of 1 per cent and resolution of 0.1 per cent. **Raymond Atchley Inc.**, 2340 Sawtelle Blvd., Los Angeles 64, Calif. L

Circle 592 on Page 19

Terminal Block

positive-locking connections made with cam-action wedges

A quarter turn with a screwdriver is all that is required to make each connection with Cam-block, a new terminal block. Connection is made quickly without solder, lugs, or crimping. Reverse rotary V-cam wedges wire ends tightly against inner walls of a rectangular bus, gripping conductor from three directions so every strand carries current. Available with any number of stations from two through 20, block takes wire sizes up to No. 18, handles up to 15 amp, and withstands heat up to 220 F. Di-



electric strength is 2500 v between terminals and 3000 v from terminal to base. **Camblock Corp.**, 825 Bronx River Ave., New York 72, N. Y. D

Circle 593 on Page 19

Miniature DC Motor

battery-operated unit has high speed accuracy

Speed accuracy of better than one part in 20,000 is provided in a new

Strength

that comes only from forging and rolling

Strength is the first requirement of any crane wheel. Nothing else counts quite so much. This wheel has it.

The wheel was machined from a Bethlehem forged-and-rolled blank—a unique type of blank that is strong all over, and all the way through.

Bethlehem's forging-and-rolling method produces blanks with excellent grain flow and freedom from porosity. The metal down inside, as well as on the surface, is of uniform quality. This makes the machinist's job easier; he can work with confidence. The blanks can be turned, bored, faced, and hobbed with complete assurance of a good finished product.

You can obtain Bethlehem forged-and-rolled blanks in a wide range of sections, and in sizes from 10 to 46 in. OD. Use them when making crane wheels, gears, flywheels, pipe flanges, turbine rotors, sheave wheels, and similar items. Prices are competitive.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

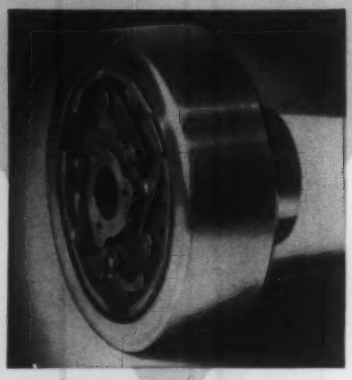
Circle 478 on Page 19

CLUTCHES FOR POWER CONTROL DESIGNS

THE NEW HILLIARD-TWIFLEX
Centrifugal Coupling

1
AUTOMATIC
smooth starting with protection against overload shock.

2
FLEXIBLE
in all directions without any loose joints.



3
ADJUSTABLE
to exactly suit the operating conditions.

4
SIMPLE CONSTRUCTION
and easy assembly even in blind installations.

HILLIARD-TWIFLEX Centrifugal Couplings provide automatic shockless power transmission and trouble-free operation even under relatively great misalignment without any lubrication whatsoever.

They are being used very successfully in the drive of compressors — agricultural sprayers — mixers — conveyors — generators — fans and blowers — pumps — hammer mills — crushers — winches and hoists — refrigeration equipment — textile machinery — and wherever smooth, efficient operation is needed.

Tests in a variety of installations for over five years prove the Twiflex is the practical solution to many drive problems.

WRITE TODAY FOR BULLETIN CE-3 WITH COMPLETE INFORMATION.

★ CONSIDER AUTOMATION-INVESTIGATE THESE PRODUCTS

• OTHER HILLIARD CLUTCHES •

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—or intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet or backstop action. Ask for Bulletin 231.

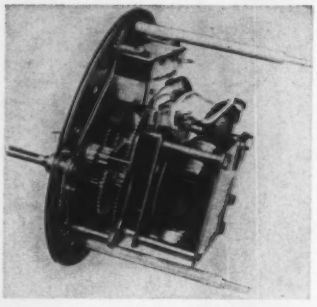
SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

THE HILLIARD Corporation
MANUFACTURING CLUTCHES FOR OVER 50 YEARS

103 W. FOURTH ST., ELMIRA, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

miniature battery-operated dc motor. Motor uses a PM magnet rotor and highly efficient field configuration, which is the coil arrangement of a transistor oscillator that is normally quiescent. Disturbance of rotor induces a signal in a pickup coil that is amplified by the transistor, increasing base current and driving transistor to saturation. Current pulse plus inertia of rotor produces and maintains rotation. Model MB-900, pictured as part of a transistor radio clock, operates at 300 rpm. Power input is approximately 900 mw, and output shaft rotates at 2.4 rpm.



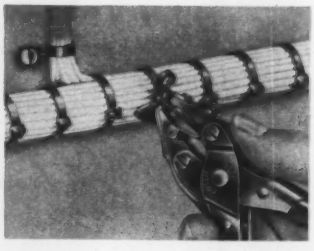
Operating range is 20 to 110 F. Power is supplied from 3600 MAH mercury batteries which operate motor for more than one year. **Park Products Co. Inc.**, 4901 Perkins Ave., Cleveland 3, Ohio. G

Circle 594 on Page 19

Nylon Cable Tie

speeds wire bundling

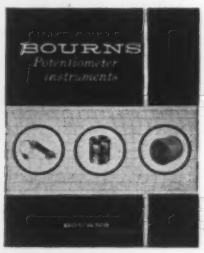
New nylon cable tie, designated Ty-Rap, provides a fast method of binding harnesses, bundles, or groups of wires. Ties make up tightly without damage to wire insulation, and remain secure without slipping or relaxing. Simple installing tool cuts tie to proper length and locks it in place. Installation is made in about 5 sec. Tie accommodates wire bundles from 1/16 to 1¾ in. in diam, and does not support com-



New literature on

POTENTIOMETER INSTRUMENTS

Linear Motion • Pressure
Acceleration



1355 proved and tested models

New literature on

TRIMPOT® POTENTIOMETERS

High temperatures • Humidity proof • Special requirements
Wirewound and Carbon
Lug, pin or insulated terminals

BOURNS
Laboratories, Inc.

P.O. Box 2112 • Riverside, Calif.

ORIGINATORS OF TRIMPOT®, TRIMIT® AND POTENTIOMETER INSTRUMENTS

Circle 480 on Page 19

bustion or fungus. Tie is available in white and colors for color-coding applications. It weighs only 1/35 oz and supports up to 30,000 times its own weight. **Thomas & Betts Co.**, 36 Butler St., Elizabeth, N. J. D

Circle 595 on Page 19

Flexible Titanium Hose

has OD of only 0.115 in.

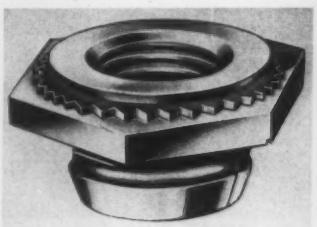
New titanium interlocked flexible metal hose has an ID of only 0.050 in. and OD of 0.115 in. Small size permits miniaturization of control elements, and makes miniature flexible hose available for use in nucleonics, rocketry, chemical and physical research, instrumentation, and other fields where larger size and material limitations prevented use of such components. **Flexonics Corp.**, Maywood, Ill. J

Circle 596 on Page 19

Self-Clinching Nut

for sheet-metal fastening

New all-metal, self-locking, self-clinching nut for sheet-metal fastening provides high torque and high pull-out resistance. Squeezing pressure applied to a clinching ring causes sheet metal to flow around



a back-tapered shank, securely locking fastener in sheet with flush fit on reverse side. Available in steel with various finishes, and in stainless steel, nut is offered in a range of sizes for use in aluminum, magnesium, brass, copper, and cold-rolled steel sheets. It meets requirements of MIL-N-25027. **Penn Engineering & Mfg. Co.**, Doylestown, Pa. E

Circle 597 on Page 19

Miniature Pressure Switch

is absolute-pressure type

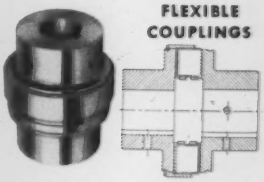
Miniature precision pressure switch line has been extended to include the

(*Please turn to Page* 156)

Lovejoy

POWER TRANSMISSION EQUIPMENT EASILY INSTALLED, MAINTENANCE-FREE

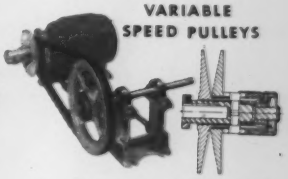
FLEXIBLE COUPLINGS



Request Catalog C-58

Bores (max.).....3/16" to 9½"
O.D. .....⅝" to 21½"
Wt. .....½ oz. to 1500 lb.
H.P. .....1/20 to 4250
Torque (static). 1½ to 5100 ft.-lbs.

VARIABLE SPEED PULLEYS



Request Catalog P-58

Bores (max.).....½" to 1⅝"
O.D. .....3" to 13⅝"
Belt Sizes.....A to 2¾ TW
Speed Ratios.....1-1 to 8-1
H.P. (1750 rpm.).....¼ to 15

UNIVERSAL JOINTS

Request Bulletin 820

Bores.....¼" to 2"
Hub Dia. .....½" to 4"
Static Torque 340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

SHAFT MOUNTED GEAR REDUCERS

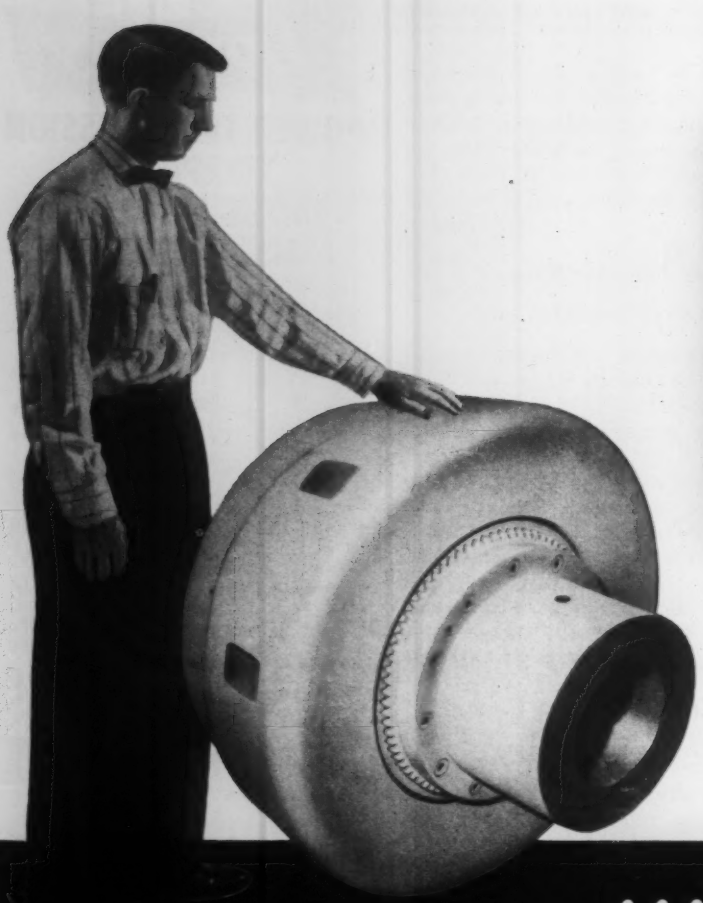
Request Catalog R-58

18 Models From Stock
Speeds.....8 to 425 R.P.M.
H.P. .....Fractional to 120
Ratios.....Single 4.5:1 Nominal
Double 14.7:1 Nominal
Hollow Shafts.....1⅞ to 5⅞ in.

Write Today!

LOVEJOY FLEXIBLE COUPLING CO.
4815 West Lake Street, Chicago 44, Illinois
Telephone: ESTebrook 9-3010

Circle 481 on Page 19



BIG

...there's a Stearns electro-magnetic to meet

CLUTCHES — torque range 0.12 to 120,000 lb ft. 6 styles — 87 standard sizes ranging from a 1⅜-in. miniature to 42-in. diameters. All are compact, ruggedly constructed, to withstand millions of cycles of operation with a minimum of maintenance. Can be actuated by a push-button, electric eye, or any other means of local or remote, automatic or manual control — permitting unlimited automatic production application possibilities for smoothly controlling and connecting machinery ranging in size from business machines and camera equipment to ball mills and steel rolling mills.

DISC BRAKES — torque range 0.5 to 7,500 lb ft. 9 styles — 70 standard sizes from miniature to large, floor or motor flange mounted. Standard, dust-tight, or explosion-proof enclosures are available in many sizes. Rugged, spring-set, electro-magnetically released Stearns brake mechanisms are designed to withstand the abuse of millions of stops with an absolute minimum of maintenance... provides "fail-safe" operation on any machine. Many units can be manually released, reset automatically, and have Stearns exclusive "Visi-wear-indicator." Torque can be adjusted quickly, easily, to provide any type stop required.

CLUTCH-BRAKE COMBINATIONS — torque range — clutch, 0.5 to 2,250 lb ft; brake, 0.05 to 1,125 lb ft. 2 styles — 75 standard sizes ranging from a 1¾-in. diameter miniature to heavy-duty 18¼-in. diameter units. Single coil construction simplifies control and installation. Friction linings are the only moving parts — assuring a minimum of maintenance or adjustment. Spring-actuated brake provides "fail-safe" operation. Adaptable to split or thru-shaft applications.

Type "SM"
ACTUAL SIZE

Matched-to-the-Machine Clutch... Brake... Clutch-Brake YOUR requirements!

STEARNS — experienced specialists in magnetic brakes and clutches — can also design and manufacture special units to meet specific production requirements... custom units to suit unusual operating conditions where a standard unit will not provide optimum performance or economy. To best take advantage of Stearns special design service, call in these experienced application-engineers in the early stages of product or machine development... initiated by a phone call to any one of Stearns' 37 district offices located in the principal cities of the United States and Canada.

For Superior Service — Performance... Specify Stearns!

Call the Stearns Representative in your vicinity for complete data on electromagnetic clutches, brakes, clutch-brake combinations. Or write, outlining your specific requirements... or send the coupon directly to...

Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY
MILWAUKEE 2, WISCONSIN

Please send 8-page full-line Bulletin No. 226F

I have an application for

☐ Brakes ☐ Clutches ☐ Combination

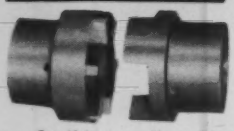
To facilitate prompt receipt of this requested information, merely staple or clip this coupon to your business card or letterhead, with your name and address clearly indicated.

Circle 483 on Page 19

Gerbing Cushion Type FLEXIBLE COUPLINGS
No Lubrication Required

These flexible cushion insert type couplings compensate for misalignment of rotating shafts and effectively absorb shock and vibration. No metal to metal contact. No lubrication, maintenance, or wearing of parts. Available in sizes from fractional to 700 HP. Inserts are available in various materials to meet all operating conditions and gov't requirements. Special bodies, bores, plating can be furnished.

Model GH*



Heavy-duty flexible coupling. Sizes from 35 to 700 HP (@ 1800 rpm). Has removable inserts held in place by steel collar to provide easy inspection or replacement of inserts. Available for shafts up to 5½" dia.

Model GHF*

Same as Model GH (above), except has flange as shown for use on gasoline motors and other drives where coupling must be bolted directly to flywheel, etc.

Model G

Available for shafts ½" to 2¼" and HP ranges from fractional thru 30 at 1750 RPM. Can be installed quickly—only 3 parts; 2 metal hubs and a flexible spider. Unaffected by moisture, abrasives, dirt, etc.

These exclusive concave jaw surfaces hold spider in position at all times—prevents insert from extruding under load.

**Models GH and GHF can be supplied with tapered bores to accommodate QD bushings.*

For detailed information request a copy of our Flexible Coupling Bulletin . . .

Gerbing manufactures a complete line of mechanical variable speed drives, fractional thru 25 HP.

Gerbing MFG. CORP.
11803 Milwaukee Ave.
NORTHBROOK, ILLINOIS
A Suburb of Chicago

Circle 484 on Page 19

you're the judge...

PROMET
ENGINEERED BRONZE BEARINGS
BUSHINGS
WEARING PARTS

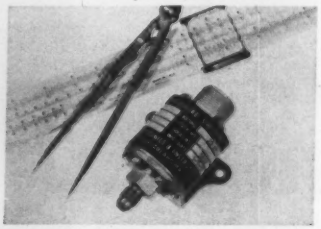
give you longer, trouble-free service or refund your money
That's our guarantee!

Write for literature and service data sheets, or send prints and condition of operation for recommendations and quotations.

Inquire About Promet Fully Machined CORED & SOLID BRONZE BAR STOCK
Saves Time, Tools & Money!

THE American Crucible PRODUCTS CO.
1321 Oberlin Avenue
Lorain, Ohio, U. S. A.

(Continued from Page 153)



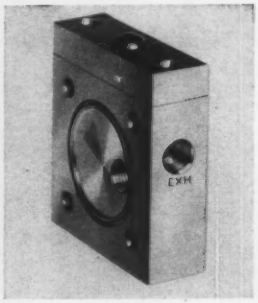
absolute-pressure type, designated Series 58,000. Line serves all operating pressure conditions from 1 to 350 psi absolute, zero to 100,000 ft altitude, and 4 in. water to 10,000 psi gage. Line of switches is suited to aircraft, missiles, and other ordnance applications, and to high-performance, automated machinery and equipment, because of light weight, compact design, accuracy, and dependability under extreme changes of environment or operating conditions. **Century Electronics & Instruments Inc.**, 1333 N. Utica, Tulsa 10, Okla. P

Circle 598 on Page 19

Ball-Actuated Valve

is only 1 in. thick and 3 in. wide

Quick-As-Wink ball-actuated spring-return valve for air, oil, or water service is only 1 in. thick and 3 in. wide. It accommodates pressures to 125 psi and temperatures to 150 F, and is tapped for either ⅛ or ¼-in. pipe connection. Valve, which permits flexibility of mounting, can be adapted easily to many mechanical applications. Ball actuator can be depressed from any peripheral point of 360-deg as long as valve plunger is given full ⅛-in. travel. Overtravel of 1/32 in. is provided. Valve is furnished in three-way normally closed or normally open and four-way actions. Stainless-steel valve plunger is hollow and radially



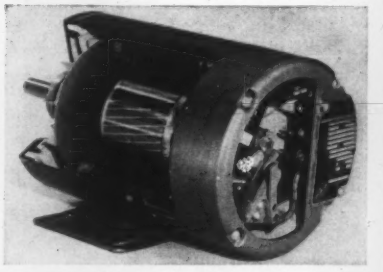
ported, and valve housing is solid aluminum. Valves can be manifolded together easily and quickly, without requiring special parts, in any of four 90-deg angle positions. **Hunt Valve Co.**, Salem, Ohio. G

Circle 599 on Page 19

Single-Phase Motors

have sealed starting switches

New single-phase motors have capacitor, switch, actuator, thermostat, and terminal board contained within a sealed capsule to provide greater motor life and protect against contamination of capacitor and starting switch. Reduced distance between bearing centers im-



proves concentricity and minimizes electrical noise. Starting switch incorporates self-cleaning, scissor-action contacts, and is actuated by a governor through a nylon button. The sealed motors are available as NEMA general-purpose, rigid-base types in ¼ through 1½ hp on the 56 frame, and as ⅓ through 3-hp blower motors in the 56-frame size. **A. O. Smith Corp.**, 531 N. Fourth St., Tipp City, Ohio. G

Circle 600 on Page 19

Flexible Couplings

for fractional-horsepower use have floating nylon center disc

Type CN double-engagement flexible couplings for fractional-horsepower applications employ a replaceable molded nylon disc to absorb shock and misalignment. Over-all dimensions of the largest unit, rated ½ hp, is only 1½ in. long and 1¼ in. in diam. Produced in three sizes, couplings are rated ⅛, ¼, and ½ hp at 1750 rpm. Couplings transmit torque loads through free-floating nylon center member for excellent resistance to shock, and afford maximum compensation for vibration

OHIO GEAR'S
New Line Of Fin Cooled
SPEED REDUCERS

Model: S-20

Model: U-20

Model: P-20

. . . handle heavier loads

. . . take less space

- Fin Cooling
- New Rugged Housings
- Smaller Size To Capacity Ratio
- Heavier Bearings
- Versatile Range of Speeds And Sizes

● These OHIO Reducers represent a new standard for rugged, compact power transmission. Called the "Series 20", the new models are available in a wide variety of capacities with reduction ratios from 9:1 through 58:1. All models in the new line feature fin cooling to permit handling heavier loads in less space.

Ask your local OHIO Distributor for complete details, or write for the new OHIO catalog.

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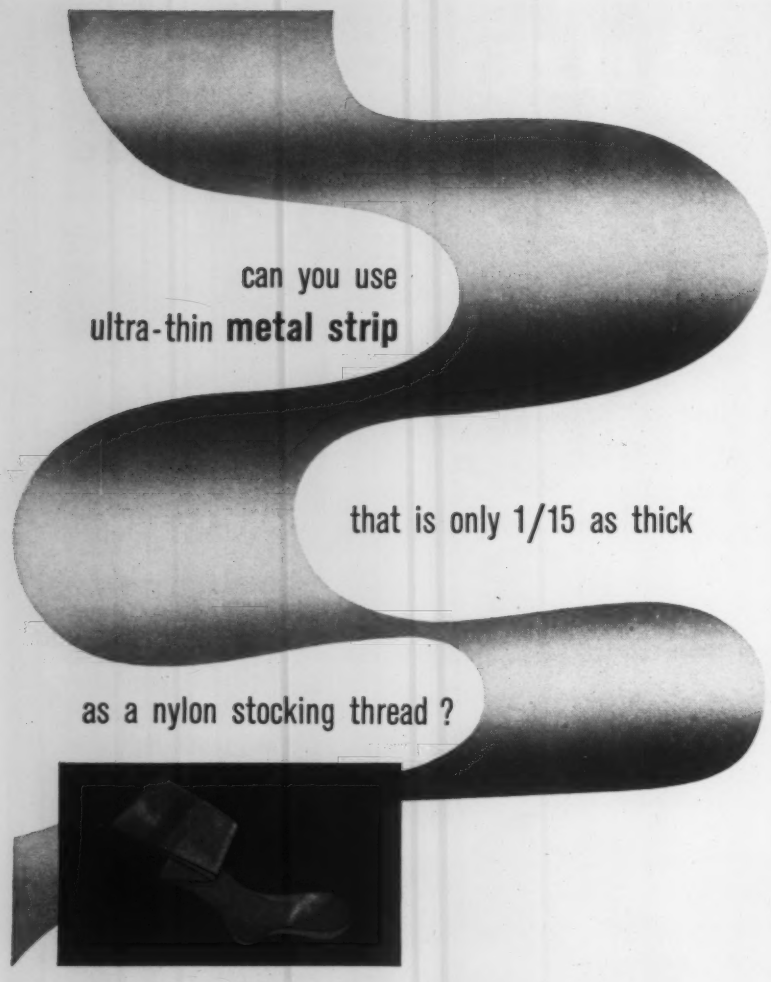
186 pages of engineering data, size and selection charts on speed reducers, gears and sprockets. Send for your free copy today!

Manufacturers of gears and speed reducers - both stock and special

hio OHIO GEAR Co.
1338 E. 179th St. • Cleveland 10, Ohio

Circle 486 on Page 19



Hamilton's Precision Metals Division is now producing metal strip and foil in practically any alloy in thicknesses ranging from .010" to .0001". (The thickness of a 15 denier nylon thread is approximately .0017".)

For designers and engineers faced with problems of miniaturization and subminiaturization, precision material like this is solving important problems today, and opening the way to future developments. Precision Metals Division strip and foil are produced to exact mechanical and physical specifications, and they are available in any quantity for development or production. Special alloys can also be developed to customer specifications and furnished in whatever form is required.

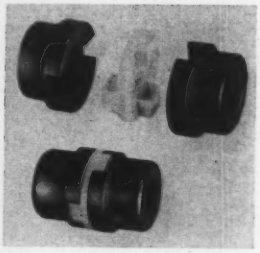
The modern, specialized equipment of this completely integrated metals processing plant is described in an illustrated facilities booklet. Write for your copy today to Dept. MD-10.

Hamilton Watch Company

Precision Metals Division / Lancaster, Pennsylvania

Creator of the world's first electric watch

Circle 487 on Page 19



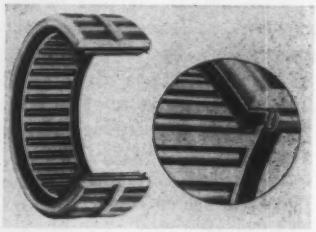
and shaft misalignment, both angular and parallel. Stock bores range from 3/16 to 5/8 in. in 1/16-in. increments, with tolerances held to +0.001, −0.000. **Climax Metal Products Co.**, 863 E. 140th St., Cleveland 10, Ohio. G

Circle 601 on Page 19

Needle Bearings

cage-type units have neoprene seals

Cage-type needle bearings are available with neoprene seals which exclude foreign matter, retain lubricant, and act as a vent to prevent displacement if additional lubricant is added. Addition of seals has been accomplished without reducing roll length or load-carrying capacity. Bearings are available in 1/2 to 2-



in. shaft diam, with two bearing lengths for each shaft diameter. Either single or double seals are available. **Orange Roller Bearing Co. Inc.**, 557 Main St., Orange, N. J. D

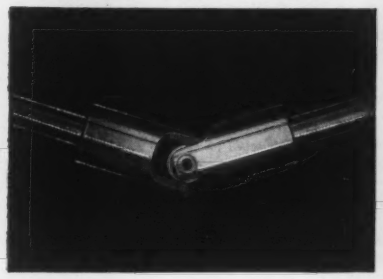
Circle 602 on Page 19

Push-Type Retainer

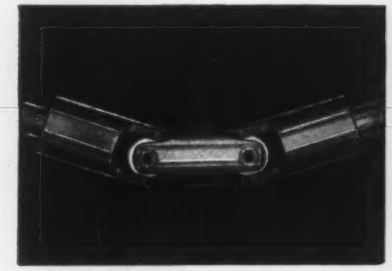
for plain rods, shafts, and axles

Type U heavy-duty, spring-tempered steel Pushnut fastener securely retains parts on plain round shafts, rods, and axles, and requires no notches or grooves. It replaces cotter pins and drilling of holes. Unit is easily and quickly applied by pushing on plain rod with simple

How Curtis helped a design engineer "BEAT THE HEAT"



This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

CURTIS UNIVERSAL JOINTS

because our catalog torque and load ratings are substantiated by constant tests under production conditions.

14 SIZES ALWAYS IN STOCK —
3/8" to 4" O.D. (6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

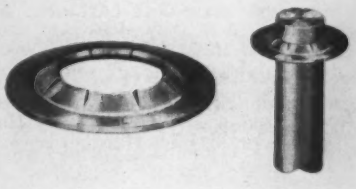
TRADE MARK **CURTIS**

UNIVERSAL JOINT CO., INC.
5 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Circle 488 on Page 19

applicator of steel tubing. Coned, notched center exerts a powerful grip on shaft, whether seated or unseated. Retainer, available for 3/8-in. diam unthreaded round rod, requires 60-lb push-on force, and provides removal resistance of 1000 lb. Over-all diameter is 3/4 in. and over-all height, 0.085 in. Typical applications include retaining wheels on axles, retention of activating rods or cranks, and for pivot-action



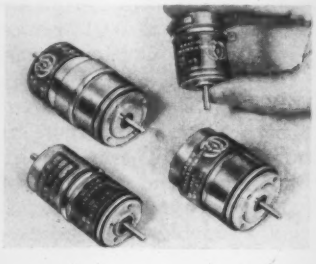
assemblies. Retainer is available in plain steel, Zinc Peen, and phosphate finishes. Palnut Co., Glen Road, Mountainside, N. J. D

Circle 603 on Page 19

Stepping Motors

rotate control mechanisms

Three new Syncramental stepping motors are for applications requiring smaller size units than previous models, and/or for applications requiring unidirectional operation. Translating pulses into incremental shaft positions, motors rotate control mechanisms, potentiometers, counters, and rotary switches on computers, missiles, recorders, and other electronic devices. Angular increment of 36 deg per pulse gives ten indexing positions with ±1/2 deg detent accuracy at maximum stepping rate of 15 per sec. Motors meet applicable environmental tests of MIL-E-5272A, and provide ambient temperature range of −55 to 80 C at altitudes to 90,000 ft. Mounting is either servo or stud, and models are available for a wide range of operating voltages. Series



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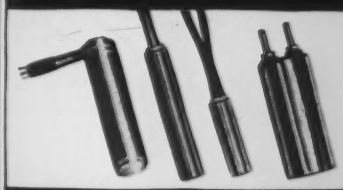
HOT PROBLEMS
with
VULCAN VERSATILITY



IN CARTRIDGE HEATERS

Vulcan Electric Cartridge Heaters are especially designed for insertion into machine parts, dies, platens, molds, presses, die blocks of embossing machines, packaging machines, etc.

You have a wide choice of standard sizes — from 1" to 25" (or longer); diameter — 1/4" to 1 13/64" (or greater); wattage — 10 to 3200 (or higher); voltage — standard 120 or 240, special 6 volts up; sheath — brass, steel, nickel or high temperature alloys; standard or special lead wires or terminals.

When your hot problems call for unusual specifications, you get a speedy solution through *Vulcan Versatility* — in design, engineering and production. Standard or special, Vulcan is ready to supply your complete needs in low cost, efficient heating units. Send coupon for Catalog and prices.

VULCAN

Cartridge Heaters • Strip • Tubular • Immersion Electric • Soldering and Branding Irons Solder and Glue Pots

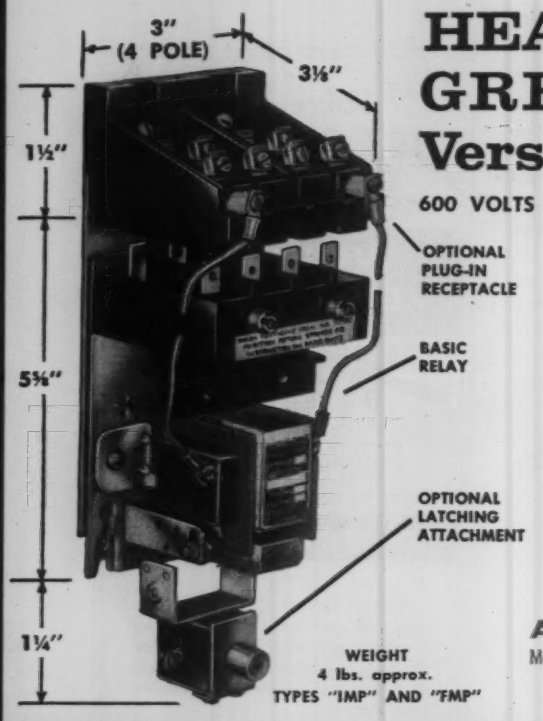
VULCAN ELECTRIC COMPANY
Danvers 6, Mass.

Please send me catalog and price information on Vulcan Electric Heaters. I am especially interested in (check)

☐ Cartridge ☐ Tubular
☐ Strip ☐ Immersion
☐ Other

NAME & TITLE.....
COMPANY.....
STREET & NO.....
CITY & STATE.....

Circle 489 on Page 19



HEAVY DUTY RELAYS GREATEST Control Versatility Ever Offered

600 VOLTS AC • 10 and 15 AMPS • 2, 3, 4, 6 or 8 POLES

- **RUGGED and RELIABLE** . . . with exceptional electrical and mechanical life. Simple construction for easy maintenance.
- **OPTIONAL PLUG-IN RECEPTACLE** . . . allows fast replacement of relay *without* disturbing wiring. Minimizes down-time on high-output machines.
- **FAST, EASY COIL REMOVAL** . . . just remove 2 screws, swing coil to front and lift out entire assembly.
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- **MOST VERSATILE LATCHING ATTACHMENT** . . . exclusive with A-H. Only attachment that converts in the field from "latch-in" to "latch-out" or "latch in-and-out."
- **AVAILABLE** . . . with AC or DC holding coils.

For free copy of the 8-page Heavy Duty Relay Catalog Section, write to The Arrow-Hart & Hegeman Electric Co., Dept. MD, 103 Hawthorn Street, Hartford 6, Connecticut.

ARROW – HART OF HARTFORD

Motor Controls • Wiring Devices • Appliance Switches • Enclosed Switches

Circle 490 on Page 19

ARROW AH HART

NEW PARTS AND MATERIALS

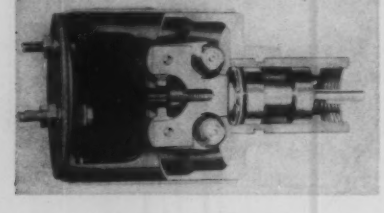
3 size has load capacity of 2 lb-in. at 20 C and is built on a 1.5-in. D frame; Series 2 has a capacity of 13 oz-in. and a 1.125-in. D frame. **G. H. Leland Inc.**, 123 Webster St., Dayton 2, Ohio. G

Circle 604 on Page 19

Underspeed Governor

provides overload protection

New underspeed governor is actually a speed-sensitive switch which operates on governor flyweight principle. Contacts are snap-acting and can be used to open or close a circuit on increasing or decreasing speed. Overload protection is accomplished by adjusting unit to trip its contacts slightly below normal



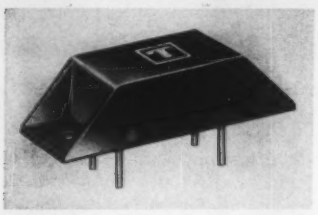
running speed. Governor can be used on almost any application where a set of electrical contacts are operated at a predetermined speed between 250 and 5000 rpm, and where normal running speed is above trip point. Governor shown is arranged for direct mounting on a standard SAE tachometer drive. **Synchro-Start Products Inc.**, 8151 N. Ridgeway Ave., Skokie, Ill. I

Circle 605 on Page 19

Reference Amplifier

is built with transistor and Zener diode

New Ref-Amp combines in a single package a voltage reference (temperature-compensated Zener diode) and an amplifying transistor. Unit provides a combined temperature coefficient as low as 0.002 per cent per deg C over a temperature range of −55 to 100 C. Use of unit permits design of regulator circuits, normally requiring ten or more components, with only one transistor, one Ref-Amp, and four resistors. Reduction in components increases reliability, doubles loop gain, and



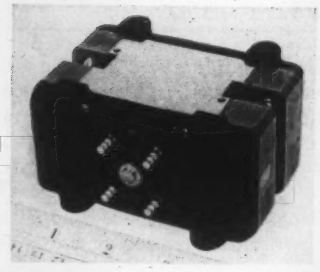
reduces space required. Package is engineered for chassis or printed-circuit mounting in any position. **Transitron Electronic Corp.**, Wakefield, Mass. B

Circle 606 on Page 19

Torque Motor

low-cost unit is for industrial applications

Model 106 torque motor, which meets nonmilitary industrial need for a high-performance, low-cost electromechanical transducer, is used primarily to actuate hydraulic servo valves and other electromechanically actuated devices. It measures 4 x 3¼ x 2¼ in., and weighs 3.4 lb. Unit delivers a 15-lb output force at midposition, and can be driven from vacuum tubes,



transistors, or magnetic amplifiers. Input power is 4 w; stroke, 0.020 in.; and hysteresis, less than 2 per cent. **American Measurement & Control Inc.**, 240 Calvary St., Waltham, Mass. B

Circle 607 on Page 19

Synthetic-Rubber Adhesives

have high shear strength at high temperatures

Three synthetic-rubber, phenolic-resin-base adhesives are designated Ray-Bond R-81001, 81002, and 81114. Used for rubber-to-metal, plastics-to-metal, metal-to-metal, and friction-materials bonding, the three adhesives are thermosetting. They differ only in percentage of solids contained, providing a choice of viscosities. Shear strength at 600 F is 495 psi. Relatively high viscosity of R-81002 permits assemblies which ordinarily would have poor contact between mating surfaces. Thick films up to 0.020-in. are easily built up. Adhesives resist all oils, brake fluids, solvents, and water. They have excellent resiliency and ability to withstand shock. **Adhesive Dept., Raybestos-Manhattan Inc.**, Bridgeport 2, Conn. B

Circle 608 on Page 19

Electrical Insulating Tape

has only moderate elongation

Type PDG electrical insulating tape is a combination of polyester warp and glass fiber yarn to which a silicone coating is calendered to one or both sides. Combination produces tape with 15 per cent elongation, no abrasion between warp and filler threads, excellent conformability, and lower price per roll. Tape adheres firmly to surface even on irregular contours. Absence of destructive friction between polyester and glass fibers under flexing and vibration prevents subsequent failure of glass yarn. Tape is supplied in any thickness from 0.010 in. and over. It is available with calender-balanced coatings on both sides, or with semicured silicone coating on one side and green or unvulcanized coating on the other, protected with 1-mil polyethylene sheet to prevent rubber transfer. Tape has applications in the manufacture of diaphragms and ducting, and in motor and generator coils. **Quaker Rubber Div., H. K. Porter Co. Inc.**, Tacony & Comly Streets, Philadelphia 24, Pa. E

Circle 609 on Page 19

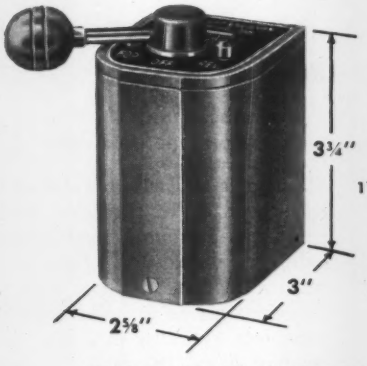
Aircraft Fasteners

can be wrench-installed for hard-to-reach applications

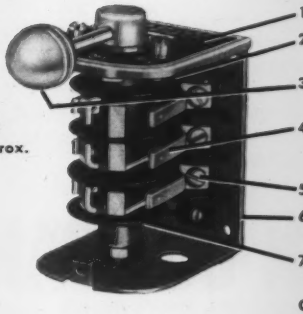
Wrench-installed Huckbolt fasteners are available for hard-to-reach aircraft applications. Wrench-in-

MOTOR CONTROLS

Reliable – Low-Cost – Durable
The NEW Type "DR" Reversing Drum Switch



WEIGHT
1½ lbs. approx.



1. Easy-To-Read Name Plate.
2. Easy Conversion from Maintained to Momentary Contact.
3. Self-Centering Handle with Positive Spring Action.
4. Heavy, Silver Plated Contacts for Long Electrical Life. Fully Visible, Easily Replaceable.
5. Easy-To-Wire Terminals.
6. Simple, Rugged Construction for Long Mechanical Life.
7. Insulation Barriers Between Contacts Prevent Flashovers.

CATALOG NO. DR-001: Size 00, has 3 poles arranged to break 2 lines to motor. Rated 1 hp maximum at 115 volts ac, single phase . . . or 220 volts ac, polyphase.

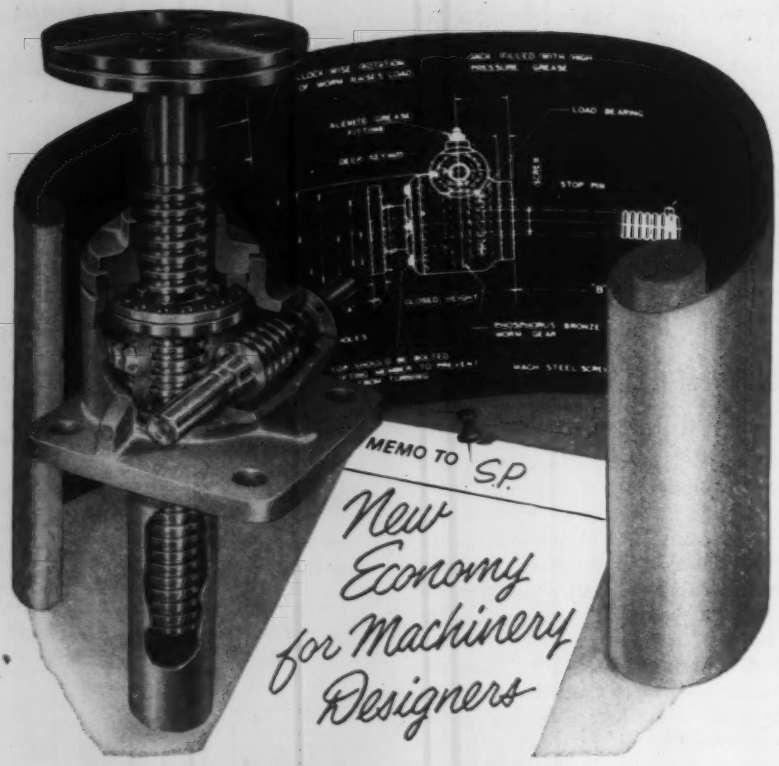
CATALOG NO. DR-02: Size 0, has contacts arranged to break 3 lines to motor. Rated 1 hp maximum at 115 volts ac, single phase to 2 hp maximum at 440-550 volts ac, polyphase.

For complete information on this new Type "DR" Reversing Drum Switch, write to The Arrow-Hart & Hegeman Electric Company, Dept. MD, 103 Hawthorn Street, Hartford 6, Connecticut.

ARROW – HART OF HARTFORD

Motor Controls • Wiring Devices • Appliance Switches • Enclosed Switches

Circle 491 on Page 19



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-V, which includes drawings and full specifications.

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION • Danville, Illinois

DUFF-NORTON JACKS
Ratchet, Screw,
Hydraulic, Worm Gear

DUFF-NORTON

COFFING HOISTS
Ratchet Lever
Hand Chain, Electric

Circle 492 on Page 19

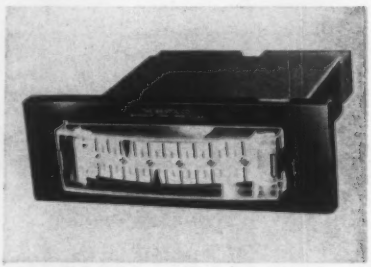
stalled configuration provides the same pull-together, tensile preload, uniformity of installation, and permanence obtained with power-tool-installed units. Fabricated of alloy steel, the fastener is available with protruding or flush-head designs in either tension or shear aircraft type. Nominal pin diameters for the AL tension type are 5/32, 3/16, 1/4, 5/16, and 3/8 in.; SAL pins are available in 3/16, 1/4, 5/16, and 3/8 in. nominal diam. Variety of grip ranges is provided for each diameter. Standard Huckbolt collars are used with the wrench-installed pin design. **Huck Mfg. Co.**, 2480 Bellevue Ave., Detroit 7, Mich. H

Circle 610 on Page 19

Pneumatic Indicator

can be mounted either horizontally or vertically

New pneumatic indicator occupies a panel surface of 6¼ x 2¼ in., and can be mounted either horizontally or vertically. It is designed



to indicate either one or two variables on a 3-in. scale with accuracy and reliability of a full-size instrument. **Bristol Co.**, Waterbury 20, Conn. B

Circle 611 on Page 19

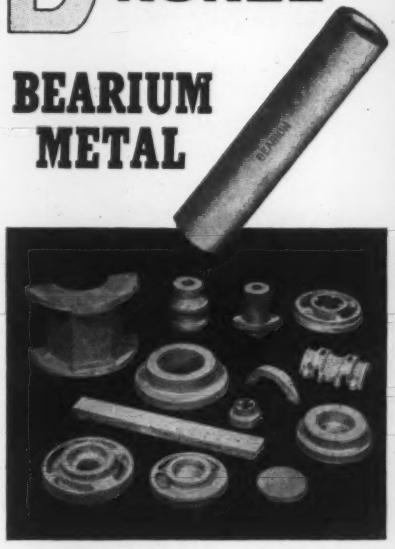
Hydraulic Cylinders

square-head units have expansion-type tube seal

Six models and additional bore sizes have been added to a line of 3000-psi, Class-3, square-head hydraulic cylinders, providing 19 basic mountings or models and bore sizes from 1½ through 12 in. Expansion-type tube seal prevents extrusion at excessive shock pressures. Positively locked, one-piece concentric piston utilizes self-compensating U-cup seals as standard components. Multiple V-ring rod seal is spring loaded

Your BEST BUY in BEARING BRONZE

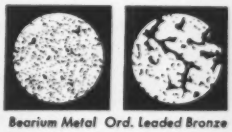
BEARIUM METAL



Words cannot describe the advantages and the superiority which BEARIUM METAL offers over all other types of bearing materials. Only when you use it under the most difficult operating conditions can you appreciate its amazing superiority.

So, if you have a bearing application which involves high speeds, poor lubrication, excessive loads, elevated temperatures, dusty and gritty surroundings—or where a liquid other than oil must be used as a lubricant ... BEARIUM METAL will prove to be your best investment.

THE SECRET OF BEARIUM METAL'S superiority is due to the uniform distribution of microscopic lead particles within the copper-tin grains rather than between the grain boundaries—as illustrated by these two photomicrographs.



Bearium Metal Ord. Leaded Bronze

FEATURES: Non-Seizing and Non-Scoring • Long-Wearing • Self-Lubricating • Low Coefficient of Friction • High Compressive Strength • Resistant to Shock Loads • Sound, uniform structure • Free Cutting.

AVAILABLE IN: cored and solid bars • centerless-ground rods • machined parts • pattern castings.

Tell us your requirements and we'll gladly furnish complete information.

BEARIUM METALS CORP.

192 MILL ST., ROCHESTER 14, N. Y.

West Coast Affiliate:

NEVIN ENGINEERING ASSOCIATES

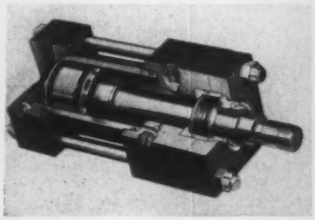
208 Toyopa Drive, Pacific Palisades, Calif.

In Canada:

BEARIUM METALS OF CANADA, LTD.

155 GEORGE ST., TORONTO 2, ONT., CANADA

Circle 493 on Page 19



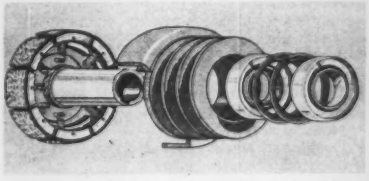
to maintain predetermined tension, and requires no adjustment. Cushion adjustment screws and ball checks of flush type maintain minimum head dimensions, and have identical seats to provide interchangeability. Cylinders comply with JIC standards and are interchangeable with other square-head units. Nopak Div., Galland-Henning Mfg. Co., 2753 S. 31st St., Milwaukee, Wis. K

Circle 612 on Page 19

Lightweight Clutches

for large engines and motors

Two new lightweight mercury clutches for larger engines and motors are mechanically operated and provide smooth pick-up and positive, no-slip power transmission. They protect engine or motor from overload and release at the predetermined speed under all conditions. No. 6510W is for gas engines up to 15 hp and electric motors to 10 hp; No. 909W is for gas engines to 25 hp and 20 hp for electric motors. Both clutches have antifriction bearrings and standard 1 7/16-in. bore,



and 5½ in. by 3AB pulley assembly. Mercury Clutch Div., Automatic Steel Products, 1201 Camden Ave., Canton, Ohio. G

Circle 613 on Page 19

Miniature Switching Relay

for radio-frequency applications

MC miniature telephone-type relay incorporates a ceramic switch stack for radio-frequency switching applications. Ceramic spacers and

GEAR-GRIP

The most revolutionary Flexible Coupling Design Development in a century!

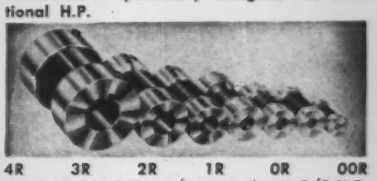
Now available for sub-fractional, fractional and integral H.P.

Ability of rubber Flex-Element to float between captive end fittings distributing load similar to universal joint action.

- LOAD RANGES—1/50 H.P. Thru 40 H.P.
- SHAFT SIZES—1/8" thru 1-7/8"
- COUPLING O.D.—.395" thru 3-7/8"
- Allowance of end thrust and specified exact over-all length per series among many design features.

Dyna-Line

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.



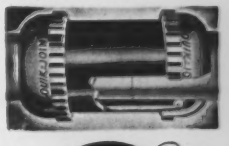
4R 3R 2R 1R 0R 00R

- LOAD RANGES—1/15 H.P. thru 1-1/2 H.P.
- SHAFT SIZES—3/16" thru 3/4"
- COUPLING O. D.—11/16" thru 1-9/16"
- Lengths varied to design specification in each series.

Quick-Joint

Steel Compression Pipe Couplings

- Now available in straight couplings, 90° Elbows, Reducing couplings, Male Threaded Adapters and Compression Tees.
- ALLOWS 14° Angular Deflection
- Guaranteed for 2000 PSI
- No threading of pipe required
- Various gasket compounds to meet hazardous and volatile fluid conditions



Put a GUARDIAN Here

YOUR UNIT

Guardian PRODUCTS CORP.

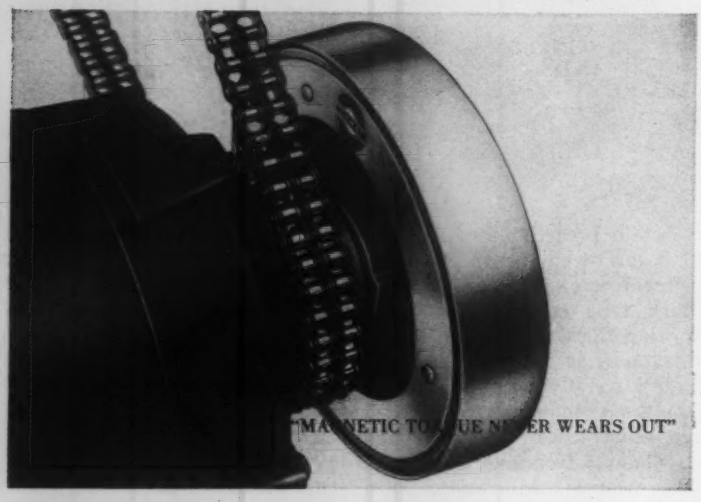
COUPLING DIVISION

Dept. M-108

Michigan City, Indiana

Circle 494 on Page 19

UNIQUE IN THE FIELD!

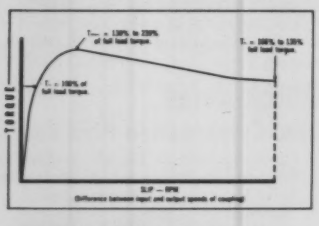


COMPLETE MOTOR DRIVE PROTECTION *with*

Whitney-TORMAG DRIVE

FULL OVERLOAD PROTECTION • CUSHIONED STARTS • HIGH EFFICIENCY • SELF-CONTAINED • TORQUE RATED • SLASHES POWER COSTS • ELIMINATES MAINTENANCE • FOR DIRECT OR POWER TAKE-OFF DRIVE •

Proven throughout industry, the new Whitney-Tormag Drive is a frictionless, permanent magnet-type power transfer unit, which insures against motor burn-outs and costly down time. Now available in 1, 2, 3 & 5 H.P. (at 1750 RPM input) sizes, ready for quick installation. Additional sizes up to 15 H.P. will follow. Torque ranges—2 ft. lbs. to 45 ft. lbs.



EXCLUSIVE OVERLOAD PROTECTION!

Operating curve illustrates fixed characteristics for optimum performance.

See These Cost Cutting Features

- Runs at full stall (100% slip) without harm to motor or driven element.
- No power loss in fluids, particles or seal friction . . . no pumps, coolers or exciters to cause power drain.
- Meets new N.E.M.A. frame specifications — compact, ready to install in minutes.
- Slip start design allows use of lower H.P. motors—cuts motor, starter and power costs.
- Cushioned starts eliminate shock, reduce maintenance costs.
- Operates from minus 60° F. to 150° F.

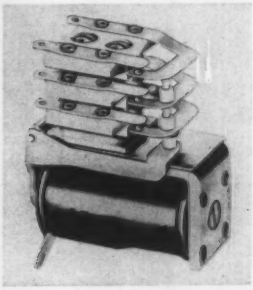
Available from stock through your Whitney Chain Distributor.

A Product of **Whitney CHAIN COMPANY**

301C Hamilton Street
Hartford 2, Connecticut

ROLLER CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS • WHITNEY-TORMAG DRIVES

pushers minimize intercontact capacitance to levels that permit switching signals of several megacycles. Capacitance ratings are 1.5 mmf between contacts in an open relay, 6.0 mmf between contacts and 4.0 mmf between contacts and case in sealed relay. Unit is



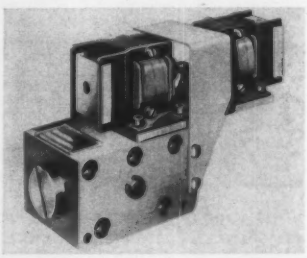
equipped with palladium contacts rated for 1 amp at 115-v 60-cycle resistive loads. Contact arrangements up to double pole, double throw or three pole single throw are furnished. Relay requires 150 mw per movable arm to operate dc models or 4.6 va to operate ac models. Maximum coil power for a continuously energized relay is 4 w at 25 C. **Potter & Brumfield Inc.**, Princeton, Ind. J

Circle 614 on Page 19

Directional Control Valve

is dual-solenoid operated

New ¼-in., four-way, two-position directional control valve is a detented, dual-solenoid-operated unit which provides remote control of direction of flow for hydraulic actuations. Flow capacity is 3½ gpm, and operating pressure is 1000 psi. Unit can be mounted horizontally



or vertically, and is available in manifold or pipe-tap styles. Valve is 8⅛ in. long, 2-3/16 in. wide, and 4½ in. high. **John S. Barnes Corp.**, Dept. MD, 301 S. Water St., Rockford, Ill. K

Circle 615 on Page 19

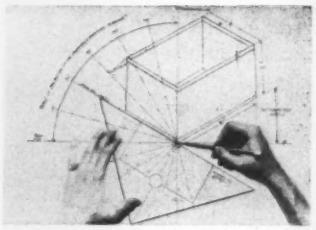
ENGINEERING DEPARTMENT

EQUIPMENT

Drafting Triangle

combines functions of a drafting machine

Pacemaker drafting triangle combines the functions of a drafting machine and eliminates use of T-square and other drafting aids. All baselines, perpendiculars, bisections, parallels, common angles, and isometric projections are projected instantly and accurately on the 14-



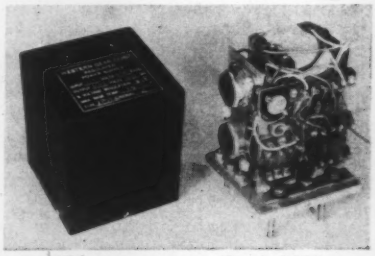
in. hypotenuse of the 10-in. Tenite-II triangle. **Pacemaker Drafting Supply Co.**, 2828 Hudson Blvd., Jersey City, N. J. D

Circle 616 on Page 19

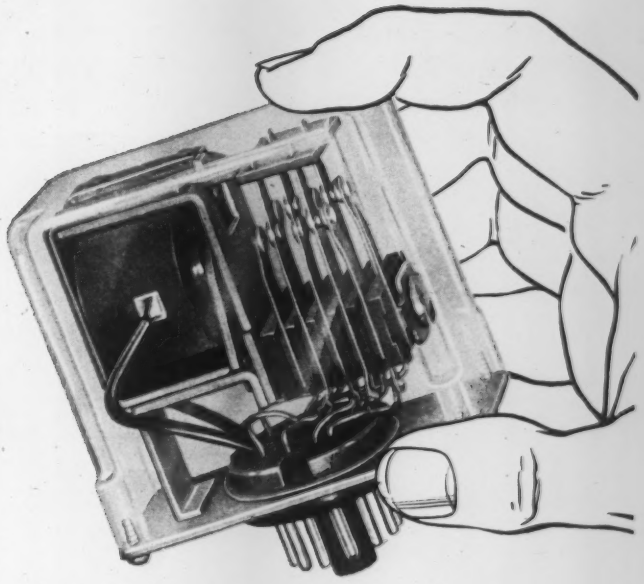
Miniature Power Supply

transistorized unit withstands 30-g vibration at 100-2000 cps

Model 7PVR20 miniature transistorized power supply has input voltage of 115 v ±10 per cent at 400 cycles and output voltage of 100 v dc at 40 ma. For current variation of 0 to 40 ma, output voltage varies ±0.03 per cent. With ±10 per cent input voltage variation, output voltage variation is ±0.03 per cent. Under temperature variation of



(*Please turn to Page* 168)



NEW, LOW COST ANSWER TO

"Over-Relayed" Industrial Controls

S-D

FRAME 219 RELAYS

Stock types are DPDT on octal plugs; and DPDT plus two normally-open on 12-pin octal plugs. AC or DC operating coils.

Dimensions are 1 1/16" wide x 2 3/8" deep x 2 5/16" high exclusive of octal plugs.

Smaller, requiring less operating power and reasonably priced, Struthers-Dunn 219 Frame Relays are a big aid to economizing complex industrial panels that are often "over-relayed" with larger, more costly contactor-type control units than are actually needed.

Accepted standards of insulation include spacings of 1/8" through air; 1/4" over surface, and a minimum of 1500 volts AC dielectric test. Other features are long life (20 million operations); plastic covers for good mechanical protection and easy servicing with plug-in construction. Contacts have 10 ampere current carrying capacity. Plug and socket combinations are the limiting factors on ratings.

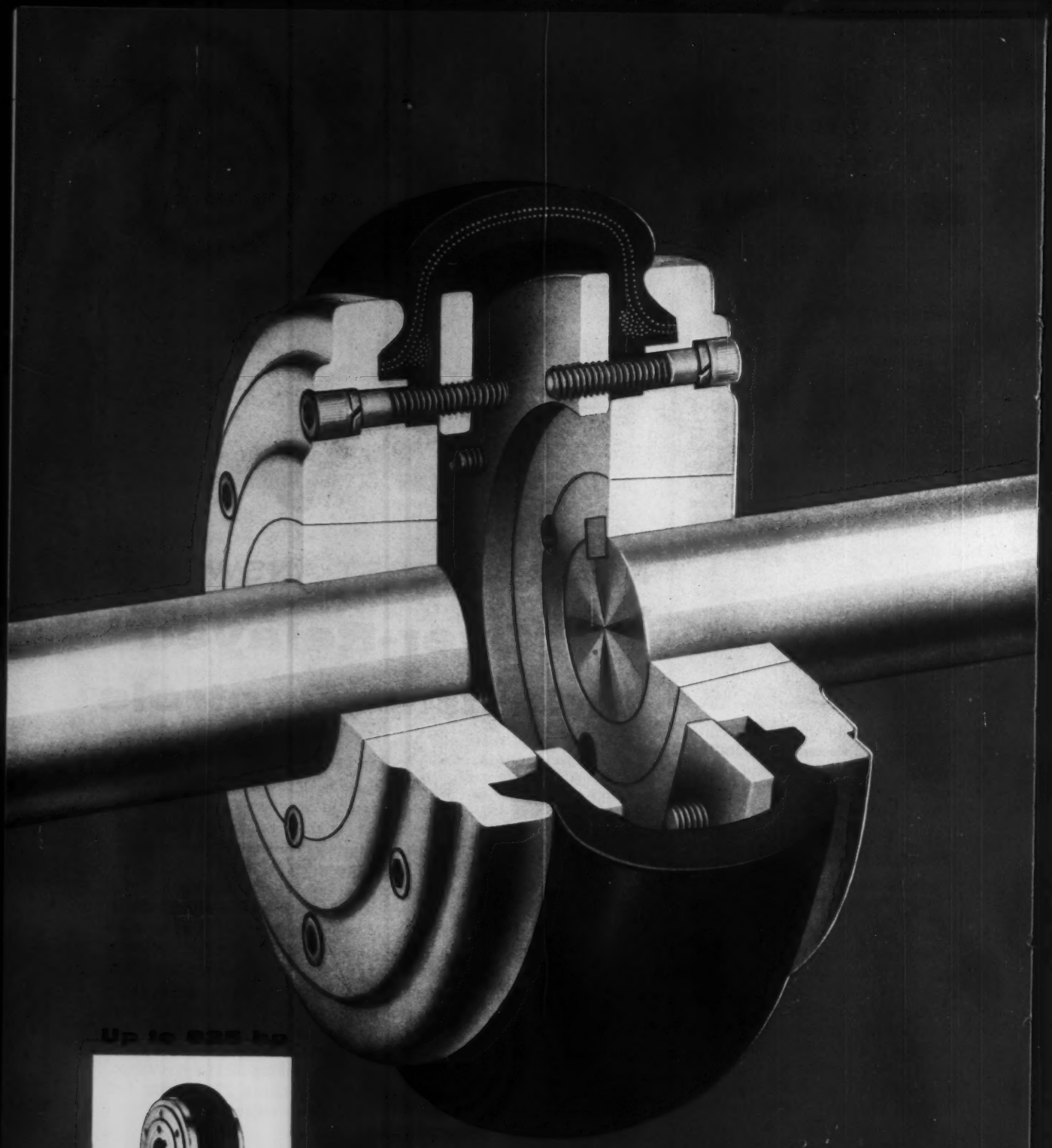
Struthers-Dunn Bulletin 2219 giving full details is available on request.

STRUTHERS-DUNN, Inc.
Pitman, N. J.

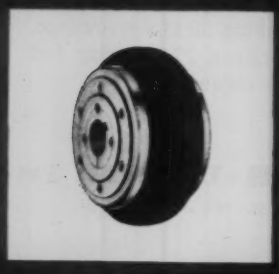
Makers of the world's largest selection of relay types

Sales Engineering Offices in: Atlanta • Boston • Buffalo • Chicago • Cincinnati Cleveland • Dallas • Dayton • Detroit • Kansas City • Los Angeles • Montreal • New Orleans • New York • Pittsburgh • St. Louis • San Francisco • Seattle • Toronto

Circle 496 on Page 19



Up to 625 hp



NOW! THE COUPLING WITH THE 4-WAY FLEX!

DODGE Para-flex

FLEXIBLE CUSHION COUPLING

THE NEW IDEA IN FLEXIBLE COUPLINGS... WITH A FLEXING BODY THAT AUTOMATICALLY COMPENSATES FOR ALL COMBINATIONS OF MISALIGNMENT AND END FLOAT... AND CUSHIONS SHOCK LOADS!

THIS Coupling "swallows up" misalignment! Its ability to handle multiple displacement is exceeded only in a universal joint. It outperforms the most complex coupling mechanisms—yet it operates with the simplicity—*and the dependability*—of a modern tire!

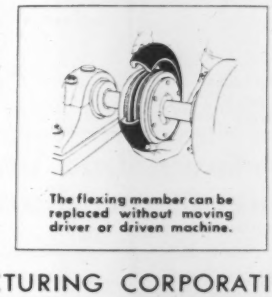
The technological advances that contribute to the miracle of today's truck tires, which are engineered to carry tremendous loads at high speeds and stand terrific shock, have made this new type of coupling possible.

The heart of Para-flex is a tire with synthetic tension members bonded together in rubber. It is pliant. It "fits itself" to changing shaft conditions—angular, parallel, end-float, *or any combination of all three!* Depending upon the size of coupling and duration of shaft misplacement, it handles angular misalignment up to 4°, parallel up to ⅛" and end-float up to 5/16".

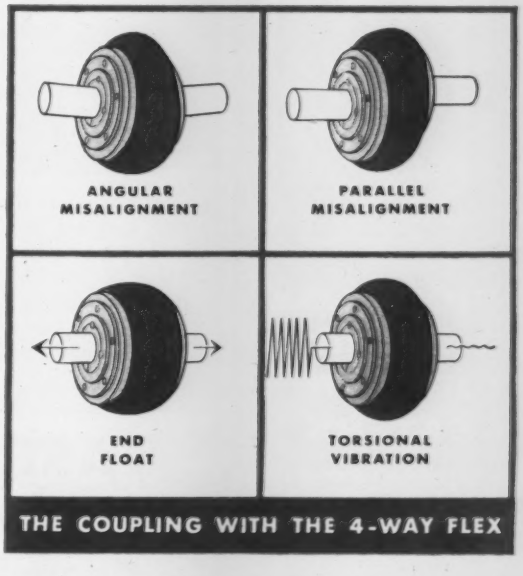
It cushions the stresses of shock loads to a remarkable degree. And it tends to absorb torsional vibration—reducing noise and protecting machinery from vibration's destructive forces.

There is no metal-to-metal contact between shafts. They are insulated. No lubrication is required.

Para-flex takes a minimum of space on the shaft. Mounting is simplified through the use of standard Taper-Lock bushings—no reboring, no machining. Safety is promoted by flush design; there are no protruding parts. And since the flexible member is molded with a transverse split, it can be replaced *without moving either the driver or driven machine!*



The flexing member can be replaced without moving driver or driven machine.



THE COUPLING WITH THE 4-WAY FLEX

Para-flex Couplings are stocked by Dodge Distributors in popular transmission sizes. They are available from factory stock in capacities up to 825 hp at 1200 rpm. Call your distributor for early delivery to *make your own test.* You'll witness something revolutionary!

DODGE MANUFACTURING CORPORATION, 3300 Union Street, Mishawaka, Indiana

DODGE

of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods in the mechanical transmission of power. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer." Or write us.

Circle 497 on Page 19

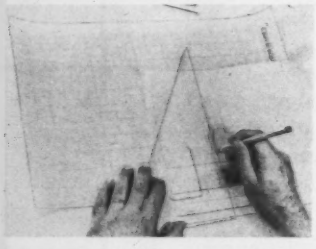
(Continued from Page 165)

−40 to 165 F, output voltage variation is ±0.05 per cent. Power supply withstands nonoperation vibration of 30 g at 100-2000 cps. It weighs 17 oz and measures 2.5 x 2.5 x 3 in. **Western Gear Corp.**, P.O. Box 182, Lynwood, Calif. L

Circle 617 on Page 19

Drafting Template

has ⅛-in. grid scale



Check-Scale drafting template permits accurate detailing, scaling, and checking of any layout or drawing. Made of 0.005-in. thick Mylar-base transparent film, template holds extreme dimensional stability, does not curl, discolor, warp, or chip, and takes penciling and erasures easily. Grid scale is ⅛ in., with 17 x 11-in. printed image. **Check-Scale Products Co.**, P.O. Box 15781, Los Angeles 15, Calif. L

Circle 618 on Page 19

Slide Rule

speeds control-engineering calculations

New control-engineering slide rule (Mannheim type) gives magnitude ratio and phase-response angle in one setting. Slide rule applies to transfer functions which are products of linear and exponential (dead-time) factors. Scales for direct conversion from decibels to actual magnitude, and from angular frequency to frequency (cycles per unit time) or period (time per cycle) are also provided. Given the various constants, rule produces magnitude ratio in decibels and phase angles in degrees for any angular frequency between 0.001 and 1000 radians per unit time. Rule is provided with A, C, C1, and D scales. **Frederick Post Co.**, 3650 Avondale, Chicago 18, Ill. J

Circle 619 on Page 19

. . . bend to the shape you need

Here is your quick, efficient and economical answer to hundreds of electrical heating problems. Clamp to metal surfaces, fit into machined grooves, cast into metals, immerse in liquids, install in ovens and ducts.

Versatile Chromalox Electric Tubular Heaters may be ordered in straight lengths or factory formed to nearly any shape required.

Select sheath metal and wattage to match your application and operating temperatures.

FREE—Send today for these 2 BIG HEATING HELPS

Catalog 50 — describes complete Chromalox line of "packaged" heaters, elements and controls.

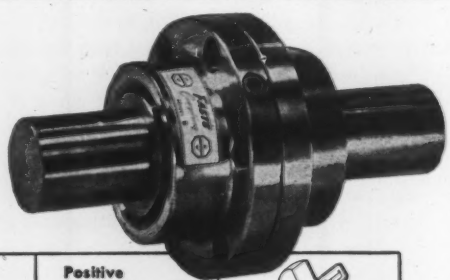
Booklet F1550 — "101 Ways to apply Electric Heat."

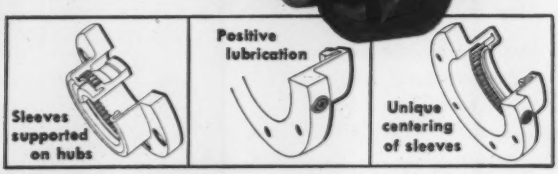
2573

CHROMALOX
Electric Heat
INDUSTRIAL · COMMERCIAL · RESIDENTIAL
EDWIN L. WIEGAND COMPANY
7575 THOMAS BOULEVARD, PITTSBURGH 8, PA.

Circle 498 on Page 19

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

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Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL *FAST'S Couplings*

Circle 499 on Page 19

THE ENGINEER'S

Library

Recent Books

Technical Drawing, 4th Edition. *By Frederick E. Giesecke, Alva Mitchell, and Henry Cecil Spencer; 844 pages, 7 by 10 in., clothbound; published by the Macmillan Company, 60 Fifth Ave., New York 11, N. Y.; available from* MACHINE DESIGN, *$10.00 per copy postpaid.*

This book covers all the basic techniques in technical drawing and incorporates the latest standards and practices, including the ASA Y-14 drafting standards. Included in this edition are sections on technical terms, do's and don'ts of practical design, and shop processes.

New Standards

American Standards. *Each publication is 8 by 10½ in., paperbound and side stapled; copies are available from The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.*

The following standards are available:

American Standard Knurling, ASA B5.30-1958; *15 pages; $1.50 per copy.*

American Standard ASA Y14.11-1958, Plastics of the American Drafting Standards Manual; *22 pages; $1.50 per copy.*

Manufacturers' Publications

Weldor's Training Manual. *144 pages, 5 by 8¼ in., paperbound, published by and available from Publications Dept., Kaiser Aluminum & Chemical Sales, Inc., 919 North Michigan Ave., Chicago 11, Ill.; $1.00 per copy.*

This book covers the primary functions essential to aluminum welding, and includes descriptive data on aluminum alloys and their characteristics associated with welding. Information on practices, filler materials, preheat temperatures, and physical properties of welding materials is presented in tabular form.

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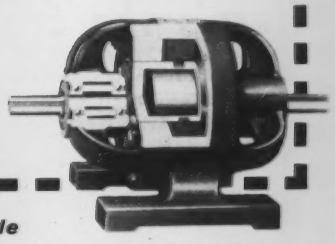

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Circle 500 on Page 19

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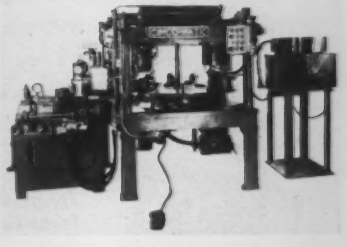
THE AUTO INDUSTRY presents another outstanding example of persistent and consistent drive for precision performance at peak efficiency. Illustrated here is Cimco's special assembly machine . . equipped with Briggs filters. Briggs plays an important part in this fast moving machine. Briggs Filters cut costs in large and small shops. If you have a problem, why not write for catalog now? No obligation.



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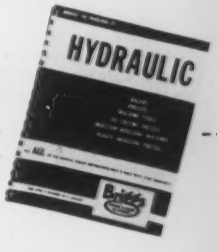

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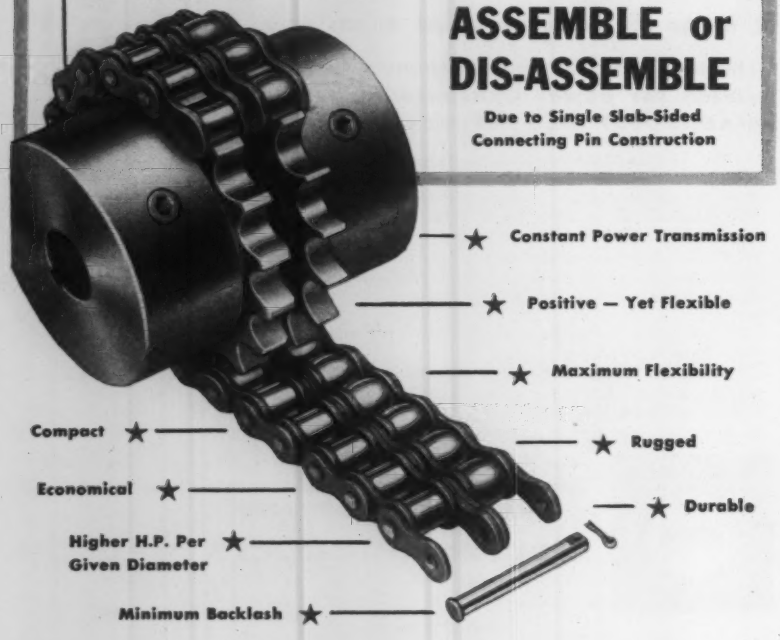

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Government Publications

Conference on Welding Engineering, PB131739; *462 pages, 8 by 10½ in., paperbound; published by and available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. $6.00 per copy.*

Thirty-five technical presentations delivered at a joint government-industry meeting sponsored by the U. S. Army Engineer Research and Development Laboratories are presented in this report.

Included are papers on welding for engineering fabrication, selection of welding processes, quality of workmanship, nondestructive testing procedures, and vibration and its control through use of welded steel.

Fatigue of Structural Materials at High Temperatures. *By B. J. Lazan; 27 pages, 8 by 10½ in., paperbound; published by Advisory Group for Aeronautical Research and Development, NATO; and available from National Advisory Committee for Aeronautics, 1512 H St., N. W., Washington 25, D. C.*

Importance of fatigue as a cause of material failure at elevated temperature is discussed. General nature of the fatigue process is reviewed with special emphasis on progressive fracture and statistical aspects.

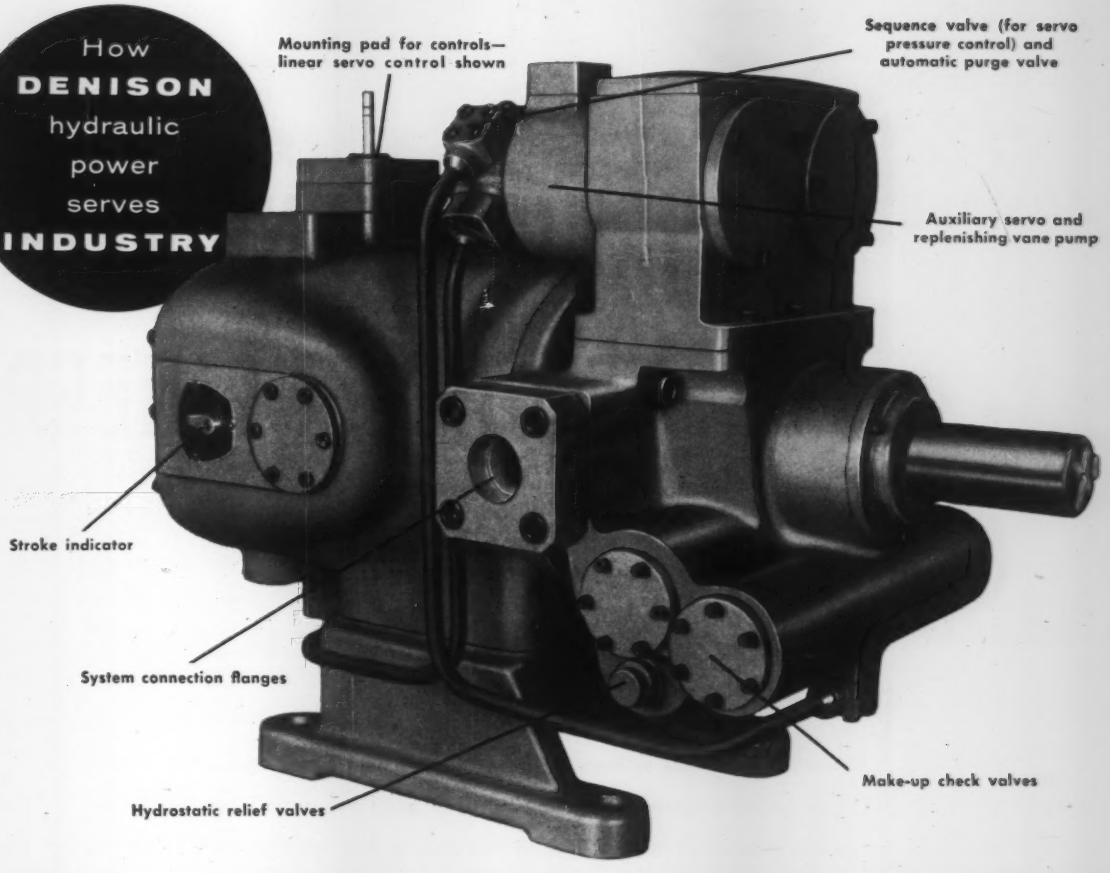
Wright Air Development Center Technical Reports. *Each publication is 8¼ by 10¾ in., paperbound, and stapled; copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

The following technical reports are available:

Effect of Prior Creep on Mechanical Properties of Aircraft Structural Metals (2024-T86 Aluminum and 17-7 PH Stainless), PB131716. *By Jeremy V. Gluck, Howard R. Voorhees, and James W. Freeman.* 106 pages, $2.50 per copy.

Effect of Prior Creep on Mechanical Properties of Aircraft Structural Metals, Part II: 17-7PH Alloy, PB 131826. *By Jeremy V. Gluck, Howard R. Voorhees, and James W. Freeman; 91 pages; $2.50 per copy.*

How **DENISON** hydraulic power serves **INDUSTRY**


Mounting pad for controls—linear servo control shown
Sequence valve (for servo pressure control) and automatic purge valve
Auxiliary servo and replenishing vane pump
Stroke indicator
System connection flanges
Make-up check valves
Hydrostatic relief valves

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Fluid Motors	**Fluid Motors**
Torque—123.6 inch-pounds per 100 psi	Torque—179.7 inch-pounds per 100 psi

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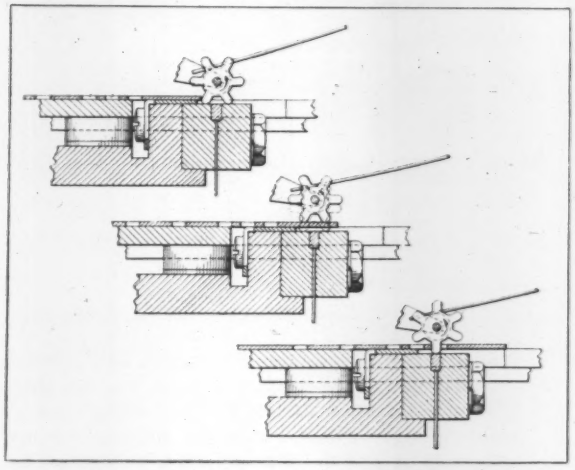
NOTEWORTHY

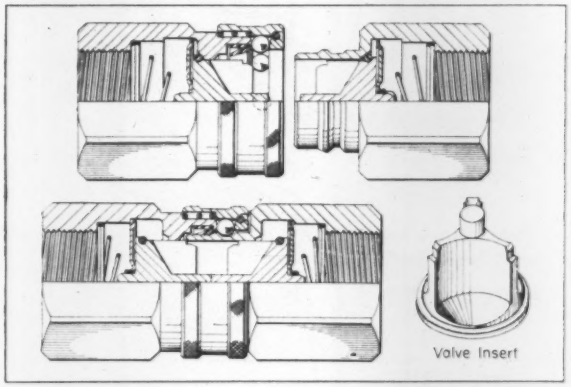
Patents

Card-Operated Rotary Contacts



A number of coaxial sprockets are rotated by perforations in cards to provide a programmed pattern of electrical impulses. As the cards, which are nonconductive, pass between the sprockets and a bank of conductors, each perforation indexes a wheel one tooth. The teeth contact the conductors with wiping action. *Patent* 2,843,319 *assigned to Monroe Calculating Machine Co., Orange, N. J., by Fritz A. Deutsch.*

Quick-Release Fluid Coupling



Both male and female assemblies of a pipe coupling contain spring-loaded poppet-like valves which stop fluid flow as the coupler is parted, then open to restore flow as the coupler is joined. Configuration of the valve inserts, which are interchangeable between the two main assemblies, minimizes restriction and turbulence of flow in the open position. The main assemblies are held in engagement by multiple balls.

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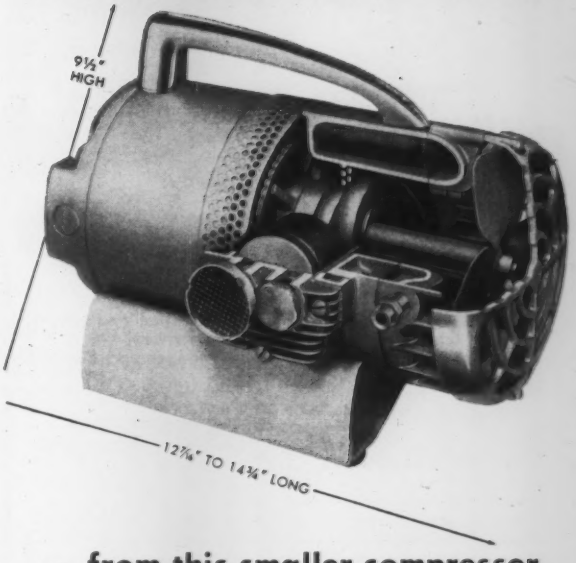

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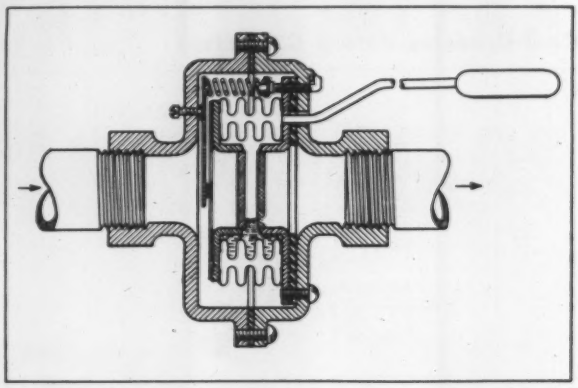
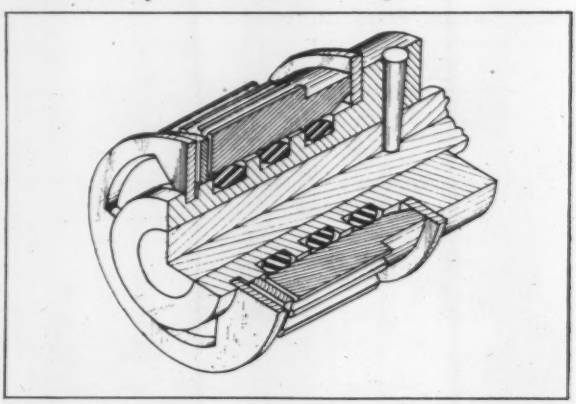
Quick disengagement is afforded when a knurled ball-retaining ring is retracted axially against its spring. *Patent* 2,850,297 *assigned to Snap-Tite Inc. by Malcolm S. Clark.*

Temperature-Responsive Gas Valve



Operation of a temperature-responsive flow-control valve is achieved by the level of a liquid between two filter-like plates porous to the gas but impervious to the liquid. Flanges which house the filter plates are held apart by a hollow annular ring, corrugated in section, connected by tube to a temperature-sensing bulb. A volatile fluid enclosed by the ring, the tube, and the bulb causes the ring to change thickness with changes of temperature. This action changes the distance between the porous plates and, in turn, the level of the barrier fluid. *Patent* 2,848,168 *assigned to Baso Inc., Milwaukee, by Russell B. Matthews.*

Limited-Torque Friction Mounting



A power-transmission element, such as a ring gear, is held on its shaft by a number of resilient O-rings which serve as friction surfaces. Round in section when unstressed, the O-rings tend to fill annular rectangular grooves on the shaft when compressed by the assembly. The rings absorb vibration and shock, limit the torque transmitted, and accommodate some misalignment in other parts of the assembly. *Patent* 2,848,884 *assigned to General Electric Co. by William A. Maude.*

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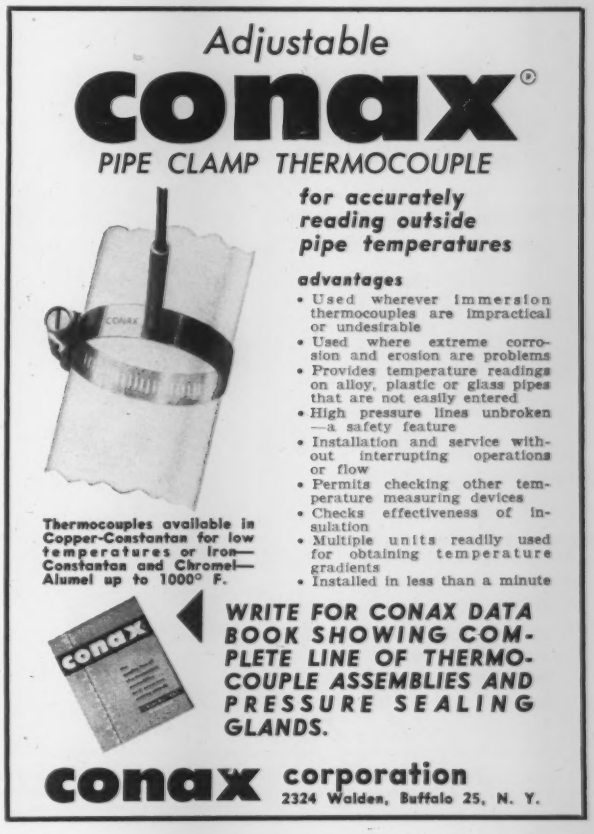
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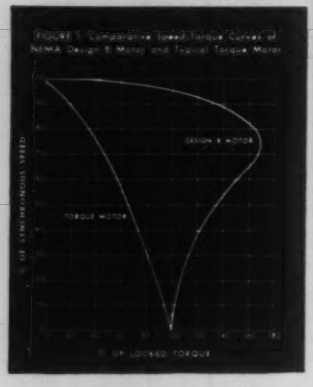
Circle 509 on Page 19

SELECTING TORQUE MOTORS

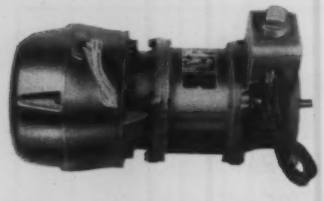
The torque motor, unlike any other electric motor, is a special from the word go. That situation alone makes Peerless one of the best sources for torque motors in ratings from 2 lb. ft. to 200 lb. ft.

Torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

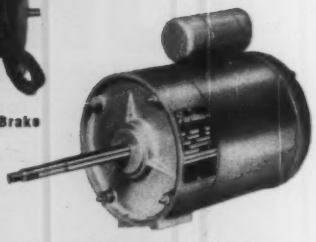
All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments; and Class A, B and H insulation are available from Peerless. Torque motors require unusually close cooperation between the motor supplier and the customer's engineers. This cooperation is a Peerless specialty. We will work with you to produce the one torque motor that powers your product best.



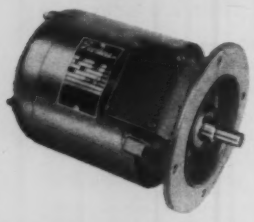
The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.



Explosion-Proof Torque Motor With Brake



Special Flange Reversing Hoist Motor Single Phase



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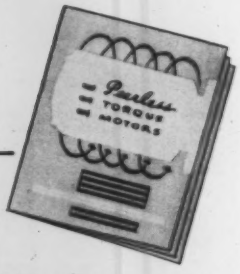
NEW TORQUE BULLETIN

This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available **Free.** Write for it today.



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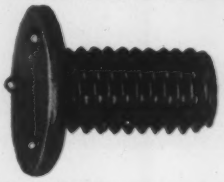
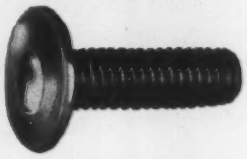
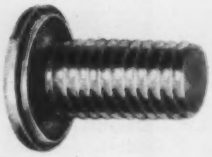


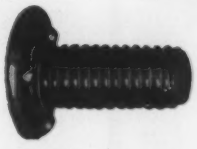
GW SCREWS — Used where design requires a smooth unmarred surface and a fastener permanently fixed in place.



HH SCREWS—Used where a single, button-type projection is required when welding to curved surfaces, to heavy sheet 3/32" or thicker, or to ends of rods.



RW SCREWS—Used where a hermetic seal is required to prevent leakage of air, gas, water, oil or dust, or when welding to perforated metal or wires.



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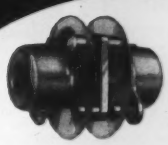

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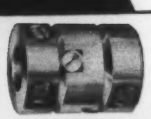

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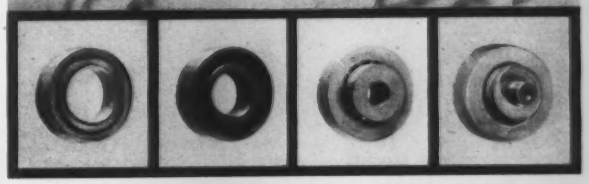

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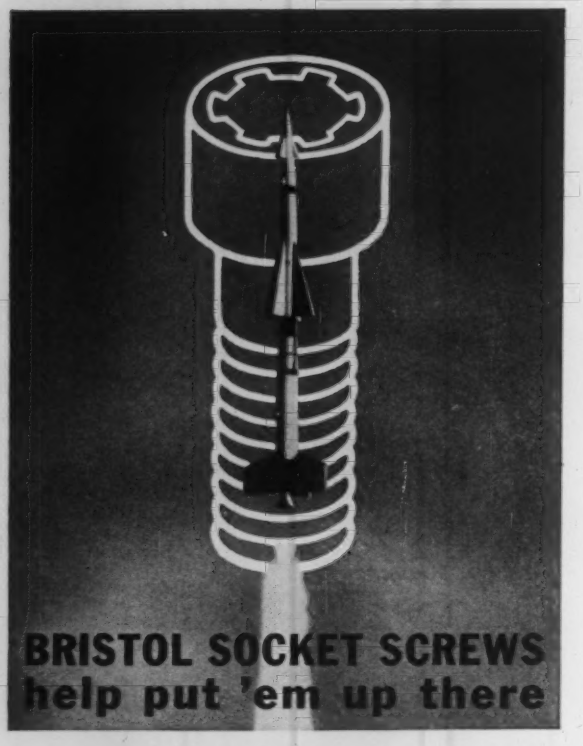

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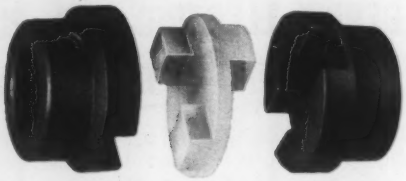

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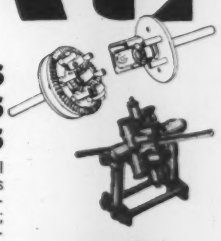

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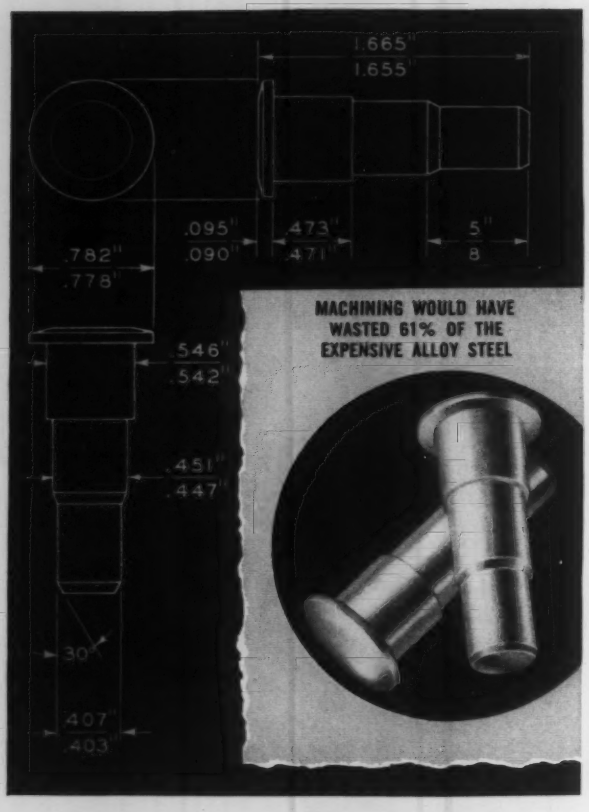

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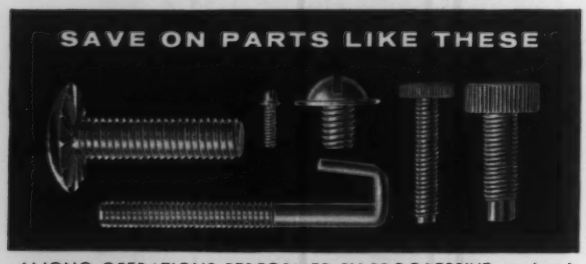

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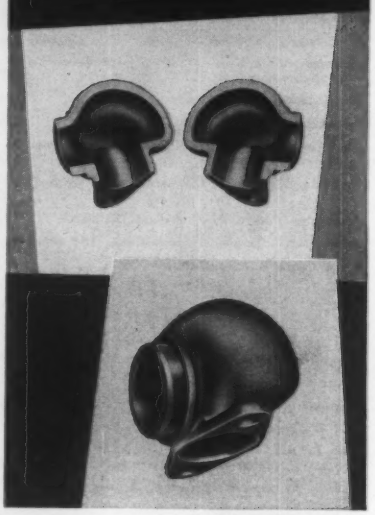
two halves *don't* make a hole!



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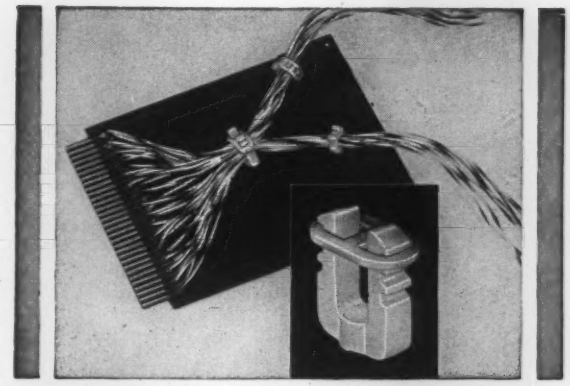

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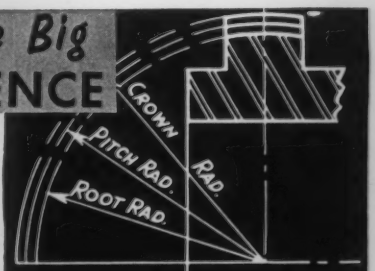

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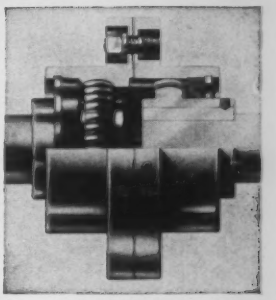

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Both vapor tension and gas-filled types are available in either distant reading or rigid stem types. In the broad Marsh line you have a complete selection of temperature ranges, case sizes, styles, and finishes.

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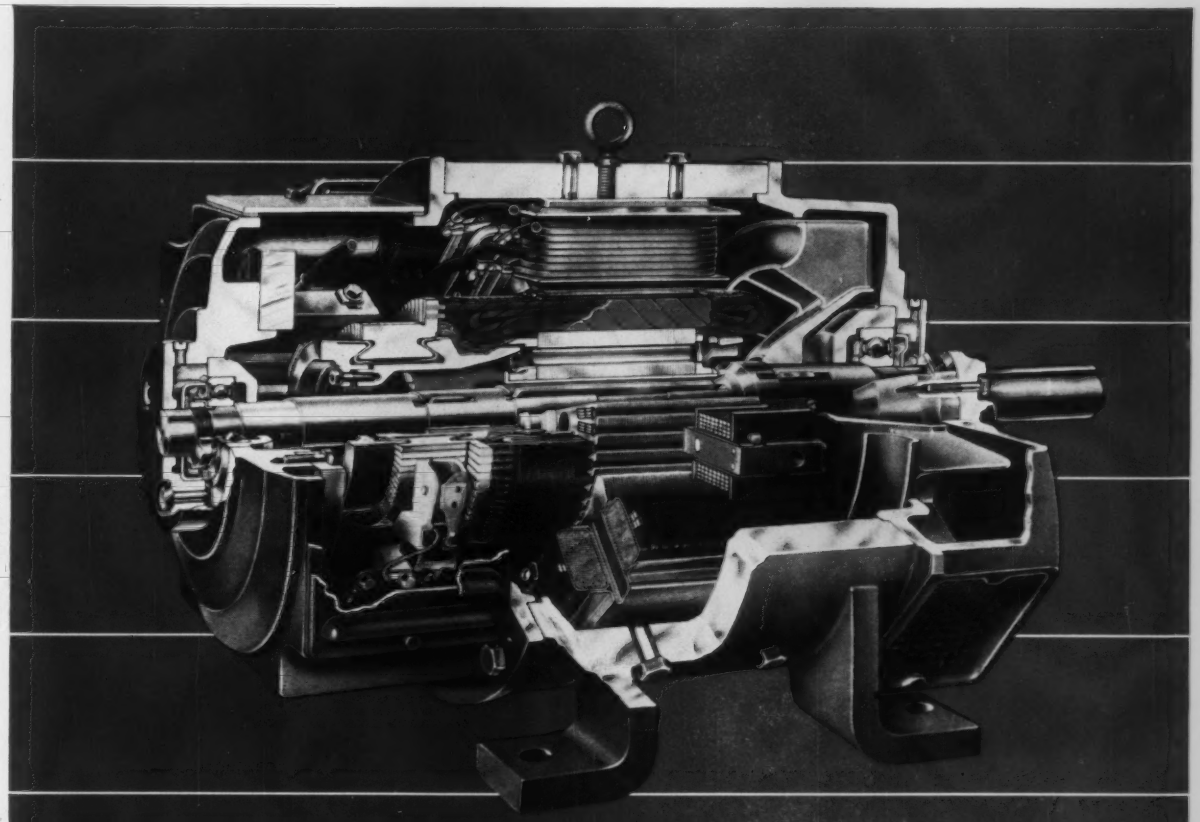

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A New Kind of D-c. Motor With DYNAMIC RESPONSE

Here is a motor built to make maximum use of d-c. flexibility. The Super 'T' puts Dynamic Response into starts, stops, and speed changes. Dynamic Response gives you a 50% increase in torque and a 50% decrease in reaction time.

This top performance is due to advanced balanced design. Lighter, small diameter armatures cut mechanical inertia 50%. Superior Class B insulation, gives extended life even at temperatures as great as 130°C.

Top grade insulation plus engineered ventilation lets the Super 'T' take tremendous overloads. In fact, the Super 'T' can develop double normal horsepower during starts, stops, and speed changes.

The Super 'T' is a compact power package, designed inside and out for tough industrial service. From appearance to performance, the Reliance Super 'T' with Dynamic Response is today's most modern industrial motor.

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Circle 402 on Page 19

3 new applications get longer life and minimum maintenance using Dodge pillow blocks with Timken® bearings

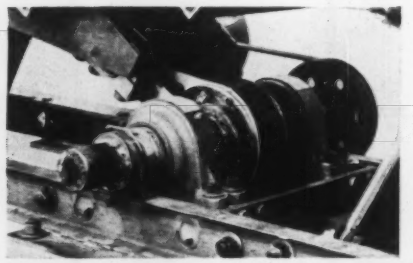
PICTURED below are three applications where Timken bearing equipped Dodge pillow blocks stay on the job with little attention under tough conditions. Their tapered design lets Timken® bearings take *both* radial and thrust loads in any combination. And full-line contact between rollers and races provides extra load-carrying capacity. Wear is reduced, maintenance is cut to the minimum.

Cutaway view shows the Dodge All-Steel pillow block with Timken bearing mounting. Of special design, the bearing has a tapered bore with self-aligning spherical outer surface —never needs adjustment.

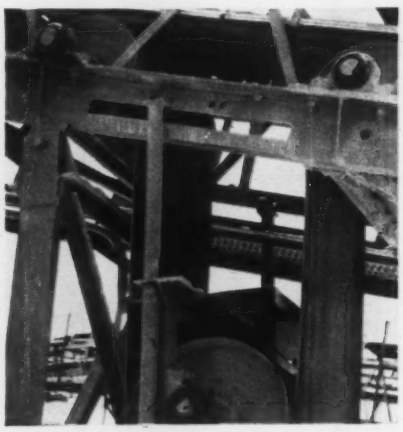
Besides the All-Steel pillow block, other versatile Dodge pillow blocks with Timken tapered roller bearings are: Type "E", Double-Interlock, Type "C" and Special Duty. All are compact in design. Special thrust devices that take up extra space are not needed.

And to get the finest steel for Timken bearings, we make it ourselves—America's only bearing manufacturer that does. So specify bearings trademarked "TIMKEN" for the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

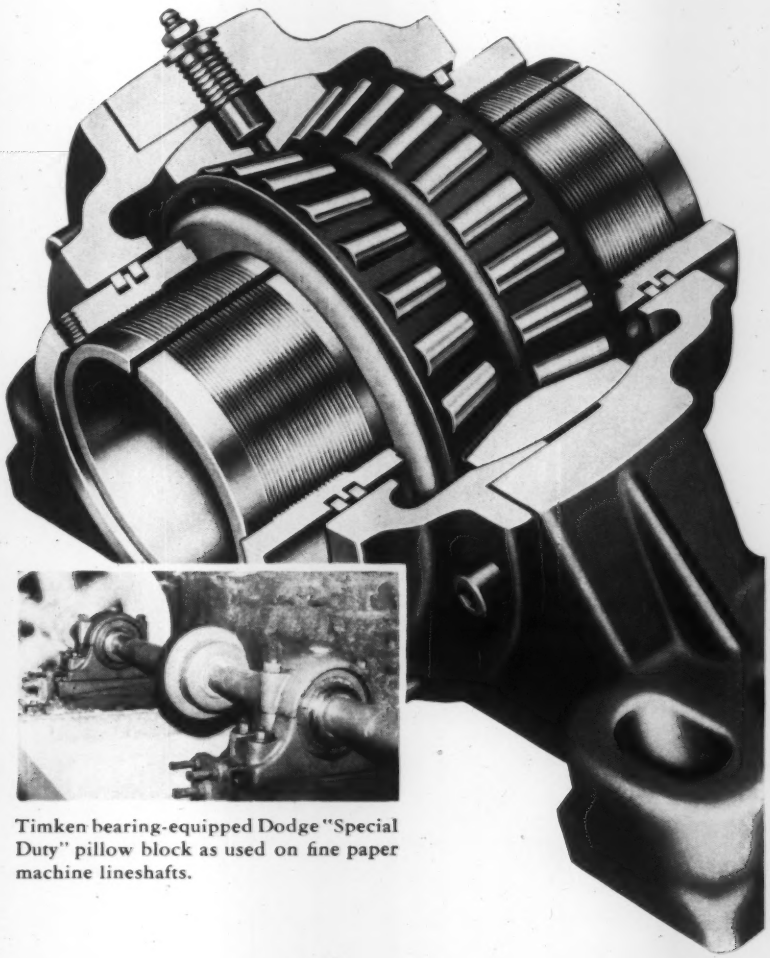
This symbol on a product means its bearings are the best.



Timken bearing-equipped Dodge All-Steel pillow block used in a vibrating conveyor.



Timken bearing-equipped Dodge Type "E" pillow block used in sand and gravel plant.



Timken bearing-equipped Dodge "Special Duty" pillow block as used on fine paper machine lineshafts.

TIMKEN *TAPERED ROLLER BEARINGS ROLL THE LOAD*

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